Soil wetting agents can carry over to following seasons on repellent loamy gravels

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Key messages

- There can be residual carryover benefits of banded soil wetting agent into the following season on repellent forest gravel soils, but the effect may not be consistent enough to rely on.
- In responsive situations it was generally better to have a 'fresh' application of soil wetter each season.
- Using banded wetting agents when seeding repellent forest gravels with a dry start to the season or when dry seeding is likely to be beneficial.
- Canola establishment is more responsive to banded wetter agents on repellent forest gravel soils than barley but better establishment doesn't always translate to higher yields.

Introduction

Water repellent soils are common throughout the higher rainfall areas of south-west Western Australia. Soil water repellence (SWR) can cause significant reductions in plant establishment and crop vigour leading to reduced yield. Severe repellence is often associated with loamy 'forest' gravels and some SWR management options, such strategic deep tillage, may not be suitable due to the abrasive nature of the soil, high incidence of large rocks or roots, and highly variable soil landscapes. In response to these factors and the proven responsiveness of liquid soil wetters on the forest gravels (Davies et. al. 2016), the use of these products is now commonplace.

As with all chemicals applied to soils and crops, there is a need to understand the efficacy, mechanisms and longevity of these products in the cropping system. There has been discussion within the cropping industries on whether or not current banded soil wetting agents have residual effects in the following season. This paper focuses on two "longevity" trials on southern forest gravel soils that are evaluating the seasonal carryover effects of two widely used soil wetter products.

Method

Two replicated trials were established on water repellent gravelly sandy duplex soils (forest gravels) at Darkan and Kojonup in 2016. The trials were designed to follow the residual effect, or longevity, of two liquid soil wetting agents over multiple years and crop rotations for up to four years to take into account seasonal variability (Table 1). Following the establishment year in 2016, the 2017 plots were sown directly over the 2016 plots.

Products were banded either with the seed or on the surface of the furrow following the press wheel. Two soil wetters, SACOA's LureH_2O® and SE14® were used at label rates of 2 L/ha and 4 L/ha respectively. Crop was sown with knifepoints and press wheels with soil conditions at sowing being moist in 2016 and dry in 2017.

Table 1. Treatment structure and crop rotation with sowing date for longevity trials at both Darkan and Kojonup. All wetter treatments applied either as banded with seed or on furrow. Crop choice for 2018 season are yet to be confirmed (TBC).

Treatment	2016	2017	2018
Nil control	No wetter	No wetter	No wetter
1st year only	Wetter applied	No wetter	No wetter
2nd year only	No wetter	Wetter applied	No wetter
1st, 3rd years	Wetter applied	No wetter	Wetter applied
2nd, 4th years	No wetter	Wetter applied	No wetter
All years	Wetter applied	Wetter applied	Wetter applied
Rotation (Sowing date)			
Darkan	Barley (19 May)	Barley (11 May)	Canola (TBC)
Kojonup	Barley (01 June)	Canola (10 May)	Barley (TBC)

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Results

2016 Season

The 2016 season was not conducive to the expression of severe soil water repellence during crop establishment. While some repellence expression was observed during the season this did not translate to large establishment or yield effects (Table 2). Establishment was reasonable at both sites with 145 plants/m^2 at Darkan and 123 plants/m^2 at Kojonup without soil wetting agents, a little below recommended target density for La Trobe Φ of 150-180 plants/m^2 (Paynter et. al. 2017). The 2016 season was also high yielding with barley yields in excess of 5 t/ha at Darkan and more than 4.6 t/ha at Kojonup. The LureH$_2$O® when applied in-furrow at Darkan was the only treatment to show any positive response compared to the control, with a 5% yield increase of 270 kg/ha (Table 2). The highly variable nature of soil water repellence on these soils can cause rapid changes in crop response over short distances and in a good season later emerging and poorer growing repellent patches can recover as the season progresses or be compensated for by better areas, therefore few statistically significant differences were found in 2016.

Table 2. Plant establishment (plants/m^2) and grain yields (t/ha) for Darkan and Kojonup sites in 2016. Treatments that are significantly different to the Control treatment are indicated as thus; LSD 5% = *, LSD 10% = #, LSD 20% = ^.

		Darkan (La Trobe Φ barley)		Kojonup (La Trobe Φ barley)	
		Establishment	Yield	Establishment	Yield
	Control	145.2	5.08	122.9	4.67
LureH$_2$O®	In-furrow	150.3^	5.35*	127.9	4.66
	On-furrow	144.0	5.18	124.5	4.68
SE14®	In-furrow	145.5	5.03	123.3	4.68
	On-furrow	145.0	5.06	127.0	4.62
	*LSD 5%	6.8	0.18	9.0	0.09
	#LSD 10%	5.7	0.15	7.5	0.07
	^LSD 20%	4.4	0.12	5.8	0.06

2017 Season

Trials in the 2017 season were sown into a dry seed bed, before germinating rains, which increases the expression of soil water repellence and impact on establishing crops. Reduced crop establishment were observed in both trials with some highly repellent sections within plots not germinating until late winter. The establishment of canola at Kojonup was more responsive to the soil wetter treatments than the barley at Darkan (Table 3). Almost all wetter treatments that included a 'fresh' 2017 application showed improvement in establishment compared to the control. At Darkan, LureH$_2$O® appeared to be more effective in aiding barley establishment than SE14® at comparative timings and placement combinations but this differentiation between products was not evident in the Kojonup trial. The residual effect of 2016 wetter applications was not strong with only the in-furrow SE14® treatment having higher crop establishment than the control at Darkan.

Overall, grain yields were higher than the respective controls for all treatments except one, but these yield increases were more significant at Kojonup (Table 3). At Darkan, only the LureH$_2$O® product when applied both years had any significant response (LSD 20%) with a yield of 4.14 t/ha compared to 3.68 t/ha for the control.

The 2016 applied SE14® treatments at Kojonup had significantly higher yields than the control treatment which indicates this product had some residual effect that carried over into the 2017 season. Residual effects from 2016 applications of LureH$_2$O® were not evident at Kojonup. All 2017 applied treatments at Kojonup resulted in increased grain yield. At Kojonup where the wetter treatments were applied in both years, there was an additive effect with yields higher than when the wetter was only applied in 2017. The biggest yield increase in this case was for SE14® applied in-furrow which when applied both years yielded 0.19 t/ha more than when only applied in 2017.

Table 3. Plant establishment (plants/m^2) and grain yields (t/ha) at Darkan and Kojonup in 2017. Treatments that are significantly different to the Control treatment are indicated as thus; LSD 5% = *, LSD 10% = #, LSD 20% = ^.

			Darkan (Spartacus Φ barley)		Kojonup (Hyola 559TT Φ canola)	
			Establishment	Yield	Establishment	Yield
		Control	105.8	3.68	33.7	2.26
LureH$_2$O®	In-furrow	2016 only	105.6	3.72	31.0	2.29

		2017 only	115.2^	3.98	36.9	2.45*
		Both years	114.4^	4.14^	41.8*	2.56*
	On-furrow	2016 only	110.9	3.97	31.7	2.30
		2017 only	112.8	4.04	41.3*	2.49*
		Both years	119.8*	3.80	39.9*	2.52*
SE14®	In-furrow	2016 only	114.2^	4.00	33.3	2.36^
		2017 only	107.4	3.94	39.9*	2.49*
		Both years	103.6	3.85	44.3*	2.68*
	On-furrow	2016 only	104.8	3.83	35.4	2.42*
		2017 only	104.0	3.84	38.1^	2.49*
		Both years	105.6	3.57	43.1*	2.59*
		*LSD 5%	11.3	0.61	5.9	0.13
		#LSD 10%	9.48	0.51	4.9	0.11
		^LSD 20%	7.4	0.40	3.8	0.08

It was observed in 2017 at a nearby trial site on a similar soil type that plots sown “row on row” had improved establishment and ground cover, comparable to the deep tillage and other wetting agent treatments at the site (data not shown). This effect has also been reported by Roper et al (2015). As a result of this evidence, and that the plots at both sites discussed in this paper were sown “row on row”, the control treatments within the trials were likely to be less affected by the repellence than the crop surrounding the trial which was not on-row sown. This may explain the lack of consistent responses to applied wetting agents in these trials in 2017 when the surrounding paddock was observed to have severe water repellence effects. In response to these observations, plots in both trials will use “off row” sowing where the 2018 season crop rows will be sown between the 2017 crop rows.

Whilst in-season field observations during 2017 indicated that there would be some placement effects when comparing in-furrow with on-furrow treatments, these observations haven’t translated to yield differences. The only occurrence where placement had a significant effect (LSD 20%) was when SE14® was applied both years at Kojonup, with the yield of the in-furrow treatment being 90 kg/ha higher than on-furrow. A similar trend was obtained at Darkan for all three year combinations but these results do not provide enough certainty to make reliable conclusions.

Conclusion

A residual effect by one of the two products tested show that applied wetters can have a positive impact on the establishment and yield of crops in the following season. SE14® showed greater residual effects than LureH_2O® at both sites. This was stronger at the Kojonup site than at the Darkan site. For both sites the effects were not always consistent and in general it was better to have a current, fresh, application of wetting agent for each season.

When comparing the yield responses of the 2016 and 2017 seasons, it highlights the negative effect of sowing into dry soils that are prone to soil water repellence. Where dry sowing is required on these forest gravel soil types, the application of banded wetters will have a significant effect on crop establishment and yield (Davies et al, 2016). This is especially true for canola establishment, although canola has a greater capacity to compensate for reduced plant number than cereals.

One initial hypothesis prior to conducting this research was that the physical placement of wetting agent products in the soil relative to the seed would elicit differing results. In other research, placement effects from banded wetting agents have been mixed, with on-furrow banding tending to be more reliable and consistent (Davies et. al. 2016). Unpublished data from the 2017 season on a similar soil type showed that the accumulation of the ground cover of wheat was faster when the wetting agent was placed with the seed compared to other on-furrow treatments. The hypothesis stated above has not been support by results to date and further research at these sites will determine if these findings are consistent or influenced by crop type.

Row placement relative to previous seasons crop rows can also effect expression of water repellence and crop establishment (Kerr et. al. 2017). In these trials repeat seeding on small plots always resulted in the crop rows being seeded on the previous seasons crop row which wets more readily and improves the reliability of crop establishment (Kerr et. al. 2017). This may have resulted in reduced expression of water repellence at the sites and, as a result, less impact from the soil wetter treatments. In following seasons plots will be sown on the inter-row in an attempt to minimise this confounding effect.

Due to the number of soil wetter products available and the soil specific responses of these wetters on different soils, additional research by product manufacturers and independent researchers will assist in generating reliable information to aid efficient use by growers.

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Key words

Soil wetting agents, non-wetting soil, water repellence, forest gravel, establishment, grain yield.

References

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