Seeder-based approaches to reduce the impact of water repellence on crop productivity: Soil wetter evaluation

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Location
Murlong
-33.691295S, 135.944050E
Mark and Amy Siviour
Rainfall
Av. Annual: 385 mm
Av. GSR: 270 mm
2019 Total: 223 mm
2019 GSR: 209 mm
Yield
Potential: 2.7 t/ha for decile 1(W)
Actual: 2.4 t/ha (B)
Paddock history
2018: CL Razor wheat
2017: CL Scope barley
2016: Pasture
2015: Mace wheat
Soil type
Grey, non-wetting deep sand
Soil test
$pH_{(Water)}$: 7.7
Plot size
25 m x 1.68 m (6 rows) x 4 reps
Yield limiting factors
Water repellence

Key messages

- **A soil wetter evaluation trial conducted over 2 years at the same site compared 15 different treatments.**
- **Six wetter treatments provided large crop establishment benefits (up to 55-60 plants/m² at 36 days after sowing) over two years, while 7 wetter treatments achieved no early impact.**
- **In Year 1, five of the better wetters produced an extra wheat grain yield (up to 0.22 t/ha), while in Year 2, all 13 wetters achieved a grain yield increase (0.5-1.07 t/ha).**
- **The best soil wetter treatment achieved only 66% of the establishment number and 85% of the grain yield of an on-row (no-wetter) sowing reference in 2019.**
- **The early impact of a soil wetter chemistry is likely to be site-specific.**

Why do the trial?

Non-wetting sands have low fertility and suffer from delayed and uneven wetting, which leads to erratic crop establishment, staggered weed germination and generally poor crop productivity due to low plant densities, low nutrient access, poor weed control and crop damage in areas prone to wind erosion. A range of trials in the GRDC funded Sandy Soils Project (CSP00203) are investigating effective solutions available at seeding time to mitigate the impacts of water repellence.

Soil wetter chemistries are varied and complex and little is known of their individual suitability to local water repellence. Modern soil wetters typically have both surfactant and humectant properties. Surfactant chemistry lowers the surface tension between the liquid and non-wetting sand, which allows the liquid to more readily infiltrate. Humectant chemistries are designed to counter the potential for excessive drainage of the surfactant in sandy soils through the use of co-polymers to promote a horizontal spread of the liquid increasing the quantity of liquid retained within the furrow seed zone. Ten years of research testing soil wetters applied at seeding time in WA was recently summarised by Davies *et al*. (2019) and found that:

- Banded soil wetters were most beneficial for dry sown cereals on repellent forest gravels, with less reliable benefits for break-crops.
- Benefits of banded wetters were minimal or at best sporadic for dry sown crops on deep sands, with no benefit under wet sowing of any crop or in any soil type.
- Benefits are larger in seasons with low and sporadic germinating rains in autumn.

Previous SA research at Wharminda on EP (Ward *et al*. 2019) conducted over 2015-2017 found that two soil wetting agents evaluated among other strategies could significantly improve wheat, barley and lupin establishment and had a positive impact on grain yield, in two years out of three. Building on the above, the Murlong soil wetter evaluation trial aimed to broaden the range of soil wetter types and combinations being evaluated under contrasting furrow placement scenarios.

How was it done?

During 2018-2019 soil wetter evaluation trials were conducted at Murlong on Eyre Peninsula (EP) (see 2018 results in the EPFS Summary 2018, P114).

Table 1. Soil wetter treatments evaluated at the Murlong site over 2018-2019.

Product names	Supplier	Rate (L/ha)	Placement zone*	$/ha (2018)
H2Pro® TriSmart	ICL Specialty Fertilisers	2	FS	15
H2Flo™	ICL Specialty Fertilisers	2	FS	16
Soak-n-Wet	Victorian Chemicals	4	FS	14
Aquaforce	SST Australia	2.5	FS	20
SeedWet	SST Australia	2	FS	17
RainDrover	SACOA	2	SZ	12
SE14®	SACOA	3	SZ	21
Aquaboost AG30 FB+AG30NWS	Bio Central Lab	2+2	FS+SZ	24
Precision Wetter + Nutri-Wet	Chemsol GLE	2+2	FS+SZ	21
Divine® Integrate/Agri mix	BASF	1+1	FS+SZ	20
H2Flo™ + RainDrover	ICL Specialty Fertilisers + SACOA	2+2	FS+SZ	28
Bi-Agra Band	SST Australia	1.5+1.5	FS+SZ	22
Aquaforce + SE14®	SST Australia+ SACOA	2+3	FS+SZ	41

**SZ=Seed Zone; FS=Furrow Surface*

In Year 2 (2019), 6 row x 25 m long plots set to 0.28 m row spacing were sown at 6 km/h using a deep banding knife point operating at 110 mm depth, followed by twin seeding discs and a furrow stabilising V press wheel, 140 mm wide. Plots were sown at 3-5 cm depth on the 15-17 May with CL Scope barley treated with Vibrance and Cruiser 350 at a seed rate of 68 kg/ha. Uniform fungicide at 400 mL/ha and Intake Hi-Load Gold fungicide at 250 mL/ha were also applied in furrow in 80 L/ha volume to address medium/high risks of rhizoctonia/yellow leaf spot and take-all, respectively. All plots were inter-row sown to barley in the standing wheat stubble, under a randomised complete block experimental design. There was an additional on-row sowing treatment with no wetter applied. All treatments were replicated 4 times and the 2018 treatments were re-applied to the same plots in 2019.

A stable consolidated furrow surface is often deemed critical to secure the efficacy of furrow surface applied soil wetters, which must be sprayed onto a firm, settled soil, and not mixed into loose backfill. Soil wetter treatments were applied in 100 L/ha volume of rainwater with foam suppressant at 0.05% v/v, using a Teejet TPU1501 low angle flat fan nozzle behind press-wheels to produce a 25-30 mm wide band footprint on the furrow surface (FS). In contrast, seed zone (SZ) applications were delivered with a Keeton in-furrow seed firmer to achieve accurate co-location with the seeds. Nutrition was supplied at 28 kg N/ha, 12 kg P/ha, 6 kg S/ha, 1.5 kg Zn/ha deep banded at furrow depth. There was also a foliar application of Zn, Cu and Mn at tillering.

What happened?

Barley crop establishment at 5 weeks after sowing is shown in Figure 1 (top). The inter-row control established at 12% of seeds sown (27 plants/m^2, respectively), indicating poor conditions for crop establishment in this severely water repellent sand, while the on-row sowing treatment (with no wetter) offered a significant establishment benefit in excess of 400% (+85 plants/m^2). In contrast, the wetters on inter-row sown treatments showed a variable early impact, and increased barley crop establishment by 17 plants/m^2 on average, with a range of 0-56 plants/m^2.

The impact of soil wetter treatments on crop establishment was similar in both years of the trial, as confirmed by a strongly positive correlation between results in each year (data not shown). Interestingly, all treatments with only furrow surface applied wetters had a limited effect on crop establishment at Murlong, while the two treatments with a seed zone applied humectant (SE14® or RainDrover) performed well. Overall, 4 out of 6 seed zone + furrow surface wetter combinations provided a significant establishment benefit compared with the control.

Combining a surfactant on the furrow surface (FS, Aquaforce) with a humectant in the seed zone (SZ, SE14®) provided a synergistic response in 2019 (where the treatment combining wetters had a greater effect than adding the effects of the two separate wetter treatments independently), possibly due to the effective water harvesting furrows kept intact over that season. A similar combination based on H2Flo™ (FS) and Raindrover (SZ) did not synergise, with the performance driven mostly by the seed zone wetter.

In 2019 (decile 1 GSR) under inter-row sowing there were barley grain yield responses to all soil wetters (Figure 1, bottom). The grain yield in the inter-row sown control averaged 1.10 t/ha.

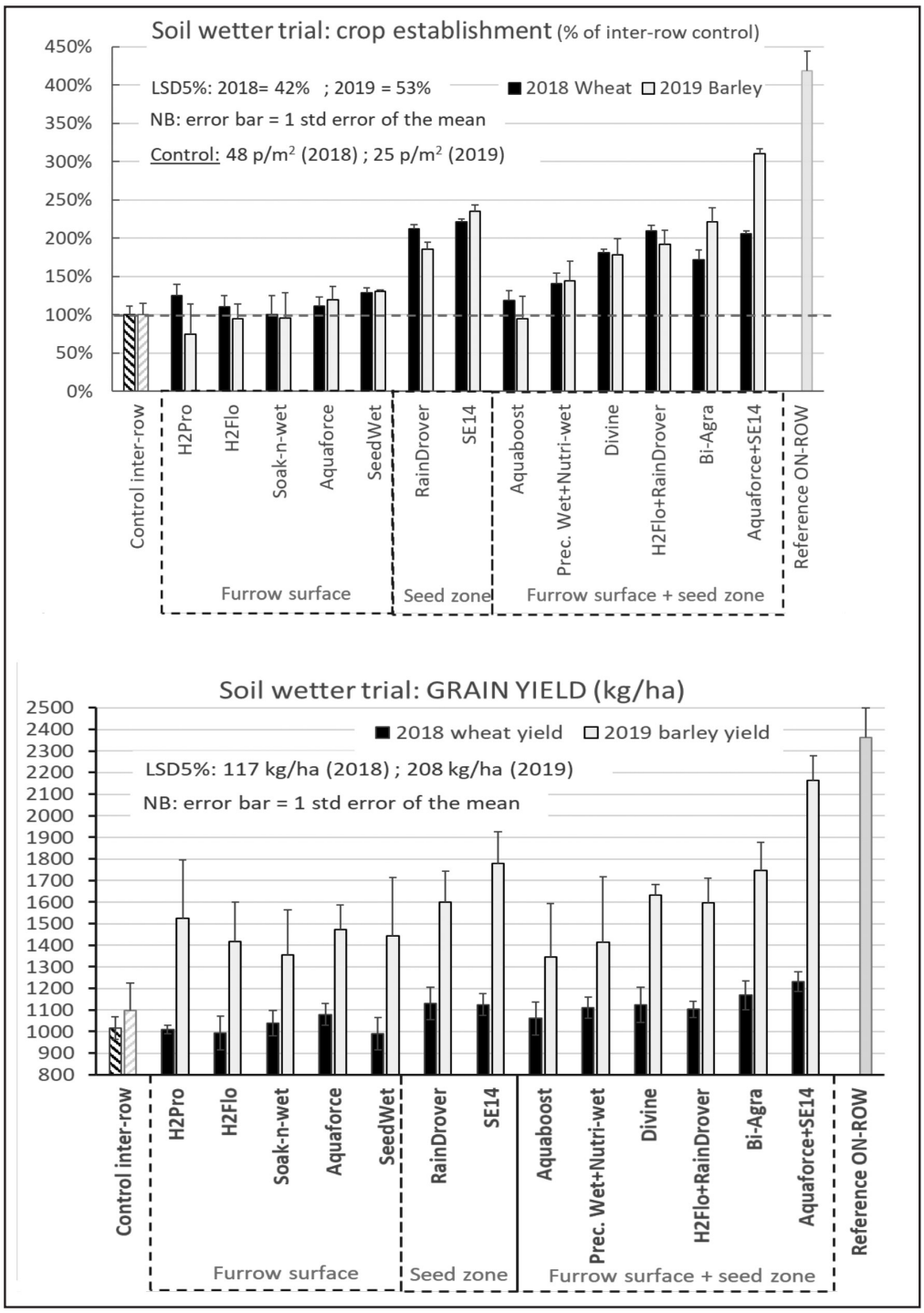

Figure 1. Effect of the 13 soil wetter treatments on: (top) crop establishment over 2 seasons (at 38 and 35 days after sowing) relative to no wetter control (control=100%) and: (bottom) grain yield (kg/ha), relative to a no-wetter control (left, 2018/19) or on-row (right, 2019). The error bars are the standard error of the mean. The 2019 soil wetter treatments and control were sown on the inter-row, with an additional on-row no-wetter reference. The wetter treatments are detailed in Table 1 and their placement varied as indicated.

On the inter-row sown plots, soil wetter treatment yield increases ranged from +23-97%, with a maximum response of +1.07 t/ha. The water harvesting furrows kept intact over the 2019 season are thought to have driven a blanket yield response to soil wetters (with total response also product specific), while in 2018, the furrows backfilled early from drift and limited wheat grain yield responses (up to 0.22 t/ha) were measured, while the early impacts on crop establishment was similar.

In comparison, the on-row control yielded the highest (x2.15 the inter-row control), providing a 1.26 t/ha grain yield benefit. A strong positive correlation (data not shown) was obtained between grain yield and plant density at 36 days after sowing (DAS), which means the soil wetters which achieved a greater early impact secured the maximum yield. Overall, the treatment grain yield responses across the two seasons were strongly correlated (data not shown). This is encouraging and suggest that an effective wetter with consistent effects across multiple years, once identified, may be safely recommended to farmers in that environment.

Table 2. Top 6 soil wetter products and placement (SZ seed zone or FS furrow surface) with significant yield outcomes. Some treatments might not be significantly from others in the ranking.

Rank	2018 wheat yield	2019 barley yield
1st	SE14® (SZ)+ Aquaforce (FS)	SE14® (SZ) + Aquaforce (FS)
2nd	Bi-Agra Band (SZ+FS)	SE14®(SZ)
3rd	Rain Drover (SZ)	Bi-Agra Band (SZ+FS)
4th	SE14® (SZ)	Divine® Integrate/Agri mix (SZ+FS)
5th	Divine® Integrate/Agri mix (SZ+FS)	RainDrover (SZ)
6th	n/a	RainDrover (SZ)+ H2Flo™ (FS)
Treatment/control	111-121 %	145-197 %
Control yield	1.02 t/ha	1.10 t/ha

Table 2 provides a synopsis identifying the top 6 performers overall for both crop establishment and grain yield at Murlong. This evaluation was conducted using a precise split seeding system (knife point + independent dual seeding discs) where co-location of seed zone wetter and seed was assured and a stable wide furrow was provided for furrow surface wetters, applied with a nozzle over a 30 mm wide band.

What does this mean?

- The top 6 soil wetter treatments used at Murlong were consistent across both years. The findings that i) the 13 product chemistries had a consistent early impact on crop establishment at this site over two years and, ii) that maximum grain yield response correlated strongly with greater early impact, are encouraging. Once a suitable product is found for a particular sand environment, it may prove reliable over many seasons and may be recommended to farmers.
- An additional factor likely influencing the cost-effectiveness of a soil wetter is the water harvesting capacity of press wheel furrows, ensuring that capacity is maximised and maintained for as long a period as possible during the season.
- The optimum furrow location, application rate and water volume per ha may require further experimentation on a product by product basis.
- The crop establishment and grain yield benefits achieved with wetters applied under inter-row sowing were not as great as those delivered with an on-row seeded crop without wetters. Analysis of the combined effects of the seeding system and wetters is available in the next article (Seeder Based Strategies).

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