Improving crop establishment in a non-wetting sand with soil wetting agents

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RESEARCH

Location:
Murlong - Mark Siviour
Rainfall
Av. Annual: 332 mm
Av. GSR: 249 mm
2018 Total: 220 mm
2018 GSR: 167 mm
Yield
Potential: 1.49 t/ha (W)
Actual yield: 1.02 t/ha
Paddock History
2017: Barley
2016: Pasture
2015: Barley
Soil Type
Grey, non-wetting deep sand
Soil Test
$pH_{(water)}$: 7.7
Predicta B (risk level pre-sowing): Take-All (Low/medium), Yellow leaf spot (medium), Rhizoctonia solani (medium), Common root rot (medium).
Water repellency profile: Water Drop Penetration Test (de-ionised water): Severe to extreme water repellency (0-10 cm), 'strong' (10-15 cm), 'slight' (15-20 cm), and non-repellent below 20 cm depth.
NB: class references: Leelamanie *et al* (2008)
MED test: 2.8 (0-5 cm) and 3.0 (5-10 cm)
Plot Size
25 m x 1.68 m (6 rows)
Trial Design
Randomised complete block design, 4 replications
Yield Limiting Factors
Extreme water repellence at the site, delayed sowing (21-23 June) due to late opening rainfall, poor rainfall over following 5 weeks (27 mm over 11 daily rainfall events, biggest event on 21 July was 6.4 mm).

Key messages

- **The impact of 13 different soil wetter treatments ranged from none to more than a doubling of wheat establishment.**
- **Grain yield benefits ranged from zero to 21% (or 0.22 t/ha).**
- **While higher grain yield generally correlated with better crop establishment, some treatments with low crop establishment were able to generate substantial yield responses, suggesting specific chemistries may promote later season effects.**
- **Combinations of some soil wetters interacted positively to maximize grain yield response.**

Why do the trial?

Previous work on Eyre Peninsula at Wharminda (Wilhelm, unpublished data) investigated the impact of two soil wetter chemistries applied within the seed row on crop establishment and grain yield. This work showed that both wetting agents increased cereal crop establishment in most trials over three years, but this rarely translated into grain yield benefits (1 trial in 6, with 1 wetting agent). This experience contrasts with extensive work in WA (e.g. Davies, 2018) suggesting soil moisture conditions at seeding have a major influence of crop response to soil wetters. Using soil wetters while dry seeding in repellent sands achieved average grain yield increases of 11% (10 trials), and 18% when dry seeding in repellent forest gravels (6 trials). These grain yield responses to soil wetters significantly reduced when seeding occurred after a reasonable rainfall, dropping to non-significant (7 trials) and to 5% average yield benefit (3 trials), respectively.

This 2018 trial was established at Murlong as part of the GRDC funded and CSIRO-led 'Sandy Soils Project' and is investigating water repellence mitigation options at seeding. The trial aims to identify the driving chemistries (surfactants vs humectants) and application techniques (furrow surface, vs seed zone) that are better able to lift crop responses under local sowing conditions. This article reports on the Year 1 data, with more work being planned for the 2019-20 seasons.

How was it done?

Trial details:

- Seeding system: knife point double shoot combined with twin seeding discs with press wheels (row spacing = 0.28 m), sowing speed: 5 km/h, sowing date: 21-23 June 2018
- Crop: Wheat CL Razor wheat sown at 63.2 kg/ha targeting 155 plants/m^2 at 80% establishment, seed treatment: Rancona C + Imidacloprid 600. Targeted seeding depth: 30-35 ±5 mm
- Fertiliser: 20 N+4.3 S as 2:1 Urea:SoA mix at 54 kg/ha deep banded at full furrow depth (100 mm), and 6 N+11P+2S+0.5Zn as Granulock Z at 50 kg/ha shallow banded 20 mm below seeding depth

- Liquids: Fungicides applied at furrow depth: Uniform 400 ml/ha and Intake HiLoad Gold 250 ml/ha applied in 80 L/ha
- Trace elements: Zn @ 2 L, Cu @ 1 L and Mn @ 3 L/ha applied as a foliar spray at late tillering
- Soil wetter treatments: applied in 100 L/ha volume with foam suppressant at 0.05%
- Weed control: Agrityne 750 @ 1.5 L/ha at late tillering
- Harvest date: 3 December 2018

Treatments:

Thirteen treatments were selected to represent a range of costs (i.e. $12-$41/ha), practicalities: i.e. single location (seed zone or furrow surface) vs split application (seed zone + furrow surface), and penetration time pre-tested on Murlong soil samples under laboratory conditions at CSIRO.

This pre-testing quantified a de-ionised water control penetration time of 120 minutes, which was reduced in solutions with the various soil wetters at recommended rates down to 2-3 seconds at best and 82 minutes at worst. This indicated a variable ability of the soil wetter products to act as surfactants (i.e. lowering the surface tension of the solution to drastically improve penetration into the soil). Various modes of action exist within the available surfactant chemistries. Equally important for sands, their ability to act as a 'humectants' (i.e. uniformly spreading out to retain water within a zone of influence) is complementary and forms the basis of the evolution of improved chemistries.

In the trials, the furrow surface applied soil wetters used a Teejet TPU1501 low angle flat fan nozzle behind the press-wheels to produce a 25-30 mm wide band spray, while seed zone applications were obtained with Keeton seed firmers fitted between the twin seeding discs.

The soil wetter chemistries included surfactant only, surfactant/humectant blends, and enriched blends with organics/ nutrients. Split applications included single products applied at 50:50 rate or combined products applied at full rate in their recommended locations. All suppliers were consulted to ascertain the recommended application rates and furrow delivery locations for each product. Table 1 summarises the details of the chemistries, their rate and the furrow application technique used.

These treatments were compared to first/last sown controls, to evaluate the impact of a 43 hour long trial sowing duration.

Measurements:

- Crop establishment at 38 days after sowing (DAS), at 77DAS (not reported here), NDVI (not reported here), grain yield.

What happened?

Selected results are presented below without labelling the chemistries until the full effect of treatments are better understood.

Crop establishment at 38 days after sowing *(Figure 1)*

Crop establishment averaged 24% of seeding rate (48 plants/ m²) for the two controls indicating very unfavourable conditions at seeding in this severely non-wetting sand. No differences were measured between the two controls.

Soils

Table 1 Soil wetter treatment details for Murlong 2018 trials

Treatment description	Wetter application details	$/ha
Control: No wetters (Sown first)	n/a	0
Control: No wetters (Sown last)	n/a	0
A: Wilchem RowLoader range *RainDrover*	2 L/ha (SZ)	12
Victorian Chemicals *Soak-n-Wet*	4 L/ha (FS)	14
ICL Specialty Fertilisers *H2Pro TriSmart*	*H2Pro TriSmart* 2 L/ha (FS)	15
B: ICL Specialty Fertilisers *H2Flo*	*H2Flo* 2 L/ha (FS)	16
SST Australia *SeedWet*	2 L/ha (FS)	17
C: SST Australia *Aquaforce*	*Aquaforce* 2.5 L/ha (FS)	20
BASF *Divine-Agri*	1 L/ha (FS) + 1 L/ha (SZ)	20
D: SACOA *SE14*	*SE14* 3 L/ha (SZ)	21
Chemsol GLE *Precision Wetter* and *Nutri-Wet* variant	2 L/ha (FS) + Nutri-Wet 2 L/ha (SZ)	21
SST Australia *Bi-Agra Band*	1.5 L/ha (FS) + 1.5 L/ha (SZ)	22
BioCentral Lab **Aquaboost AG30** Combo	AG30NWS 2 L/ha (FS) + AG30FB 2 L/ha (SZ)	24
= B + A	*H2Flo* 2 L/ha (FS) + Wilchem *RainDrover* 2 L/ha (SZ)	28
= C + D	*Aquaforce* 2.5 L/ha (FS) + SE14 3 L/ha (SZ)	41

Key: SZ=Seed Zone; FS=Furrow Surface

Soil wetters lifted crop establishment by 25 plants/m^2 on average, with a response range of 0 to 58 plants/m^2 (a maximum of 122% increase).

Four subgroups of responses were defined, namely:

1. A top level subgroup with four treatments more than doubling plant density, borne out of two humectant chemistries (T1 and T4) applied in the seed zone (NOTE: no improvements were measured when combined with a furrow surface applied surfactant).
2. Two other treatments (T10-T11) achieved an intermediate performance generating 70-80% crop establishment increase, both being applied at 50:50 split rate between furrow surface and seed zone (their relative impacts will need to be unpacked in a future trial).
3. A low response subgroup with three other products generating in the range of 20-40% increase.
4. A no response subgroup with four treatments, which did not produce any significant impact on early plant establishment.

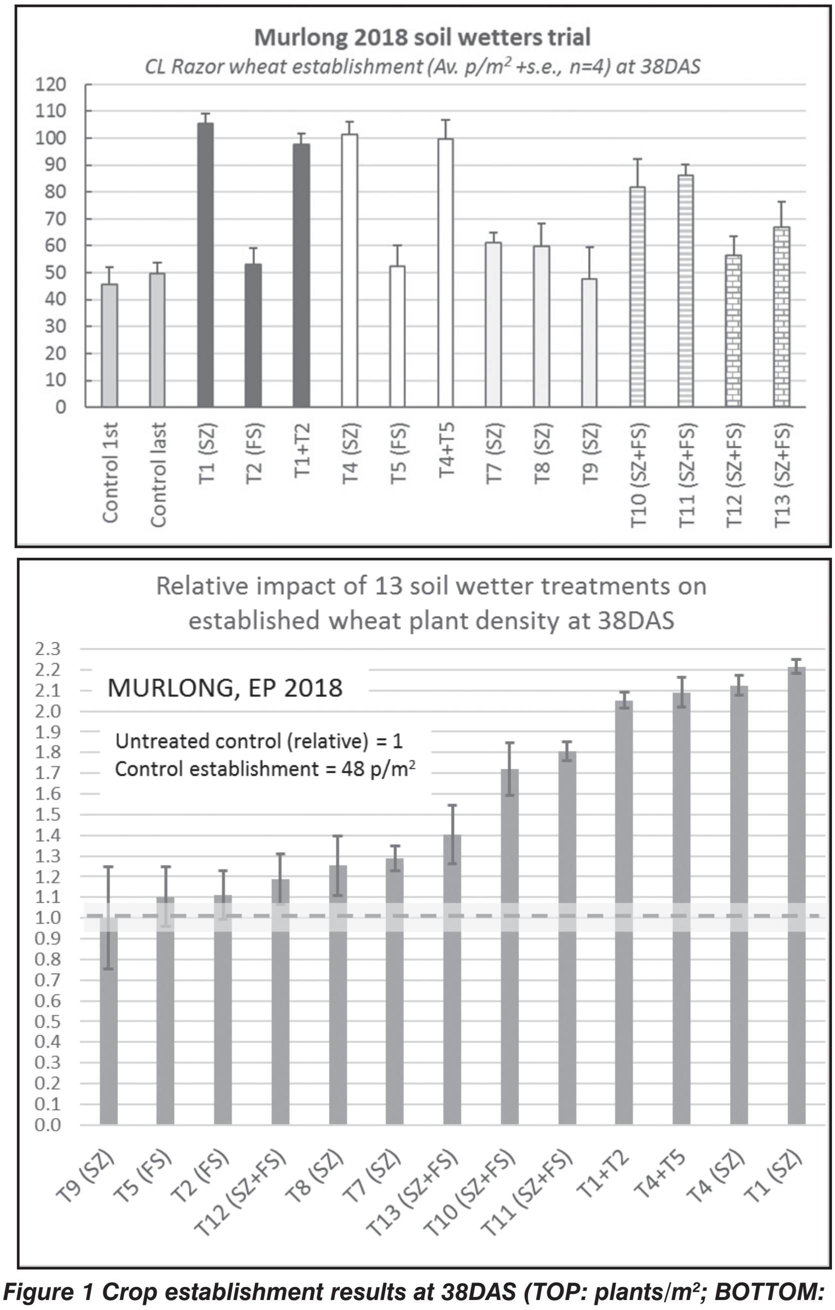

Figure 1 Crop establishment results at 38DAS (TOP: plants/m^2; BOTTOM: relative to control)
Note: treatment error bars represent ±1 std error of the mean

Overview of grain yield response *(Figure 2)*

Controls averaged a grain yield of 1.02 t/ha. Treatment grain yield responses ranged from 0 to 21%, a maximum of 0.22 t/ha (P<0.01).

There was a significant positive correlation (r = +0.76) between grain yield and plant density at 38DAS (Figure 3), whereby the better established treatments tended to achieve higher grain yields. Figure 3 suggests clusters of data points, whereby some high early impact treatments (T1, T4 and T4+T5), which had at least doubled early crop establishment, generated 8-12% grain yield response. In contrast, a similar high early impact treatment (T1+T2 combined) was able to maximise crop yield response to 21.3%, suggesting a later in-season synergy relative to T1 only or T2 only, which yielded significantly less on their own. While T2 alone did not have any effect on crop establishment and no significant impact on yield, only the T1 chemistry drove the early crop response in the combination treatment, and the combined products later synergised to maximise yield gain.

Conversely, an alternative combination of surfactant and humectant products (T4 and T5), compared alone and in combination, did not show a later in-season synergy, suggesting product chemistries have their own signature potential.

Interestingly, intermediate early impact treatments (e.g. in the 40 to 80% crop establishment impact range) could still achieve 10 to 15% grain yield increase. The spread of data in Figure 3 suggests some soil wetters may have the capacity to more effectively impact crop response despite similar impacts on crop establishment. More work is required to validate these observations across contrasting seasons and non-wetting soil types.

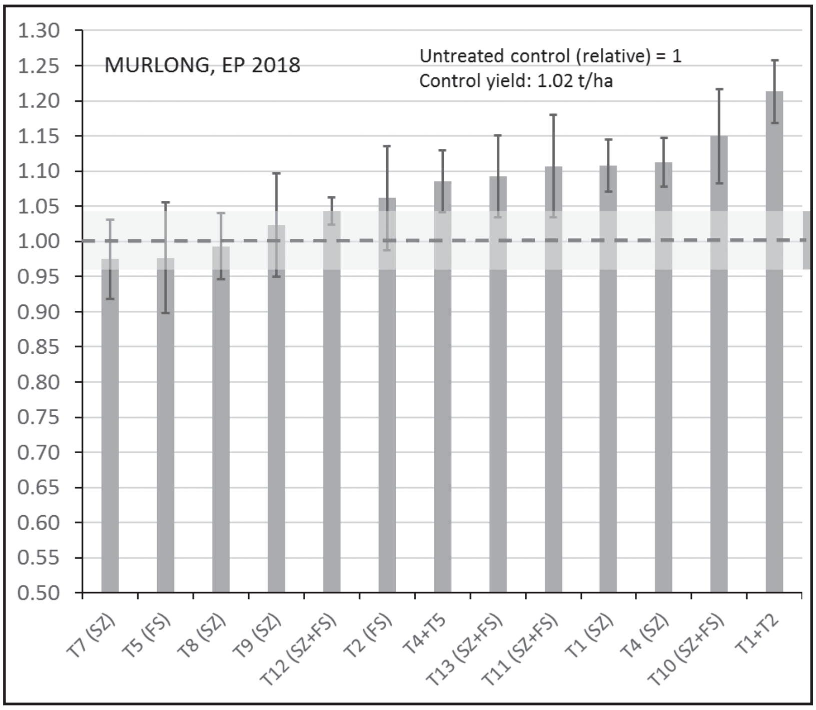

Figure 2 Wheat grain yield overview (relative basis)

NB: dashed line is the relative control ±1 std error of the mean as the shaded zone.

Treatment error bars represent ±1 std error of the mean.

What does this mean?

This first year of trial data show encouraging results on the ability of some soil wetter chemistries to improve seed germination in a highly water repellent sand. Under the seasonal conditions, plant density was a significant factor in generating yield gains at harvest, which correlates well with responses to soil wetters found in WA research using a number of similar new chemistries.

The data also suggest that factors linked to specific chemistries are playing an additional role in-season leading to associated yield gains, and it seems there is a potential to mix product chemistries as a way to generate synergies in responses. More work is being planned over the 2019-20 seasons to help develop recommendations for grain growers. Some validation across different water repellent sands will also be required.

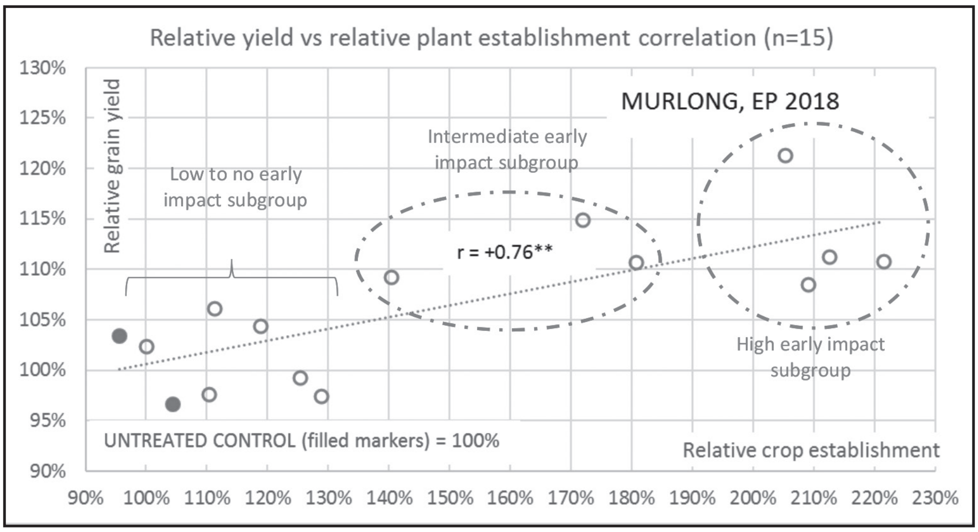

Figure 3 Correlation between grain yield and crop establishment data (relative basis)

Note: relative to a low/no early impact subgroup (left), two treatment clusters may be identified which performed differently at 38DAS but which attained a relatively similar range of grain yield impact (with 1 outlier combination treatment performing best).

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