

# On-row seeding as a tool for management of water repellent sands

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## Abstract

Water repellent (non-wetting) sands are prevalent in many crop-producing regions of southern Australia, and pose challenges for crop production in terms of crop establishment, nutrition, and weed control. In this research we investigate the tactic of on-row seeding, compared with inter-row seeding, over two successive years (2012-13) on a trial near Calingiri, Western Australia. During August in both years, plots established using on-row seeding were less-severely repellent, with MED values in the crop rows of 2.8 and 2.9 in 2012 and 2013 respectively, compared with MED values in the crop rows of inter-row sown plots of 3.3 and 3.3. In 2012, crop emergence was significantly greater (147 vs 79 plants per square metre) in the on-row sown treatment, but there was no significant difference in 2013 (86 vs 80 plants per square metre). There was no significant difference in crop yield in 2012, with an average wheat yield of 2.1 t/ha, but in 2013, inter-row sown barley yielded 3.2 t/ha compared with on-row sown barley 2.9 t/ha ( $p = 0.03$ ). Yields in both treatments in 2013 were affected substantially by ryegrass. Despite the lack of positive yield response, changes in MED values and crop emergence suggest that on-row seeding may be a viable tool for long-term management of crop production in water repellent soils.

## Key words

Water repellency, crop row placement, germination

## Introduction

Soil water repellency is cited by many farmers in south-western Australia as one of their main soil constraints to crop production (Davies et al., 2013). Water repellent soils are also prevalent in parts of South Australia and Victoria, and have been estimated to affect more than 10 M ha of sandy soils across southern Australia (Roper et al., in press). Rainfall infiltration into water repellent soils is characteristically patchy, resulting in patchy and staggered crop germination, and also staggered germination of weeds.

Some farmers on the south coast of Western Australia manage water repellency by maintaining full residue retention combined with minimal soil disturbance (Hall, 2009; Roper et al., 2013). In this system, the severity of water repellency is actually increased (Roper et al., 2013), but higher soil water contents, and better crop yields, are observed than when these systems are perturbed by residue removal or soil tillage. Roper et al. (2013) attributed this to the maintenance of preferred pathways of water entry into the soil, often along the old intact crop root systems, as also speculatively proposed by Blackwell (2000).

This suggests that crops sown immediately alongside the old crop rows may have better access to soil water, and may perform better, than crops sown in between the old crop rows. Farmer observations have supported this hypothesis (Steve Waters, personal communication; Figure 1), and have even led to development of machinery specifically designed to allow close on-row seeding (e.g. the iTill system; Paul Hicks, personal communication; see also [www.itill.com](http://www.itill.com)). In this research we investigate crop emergence and yield, and soil water repellency, for crops grown on the old crop row, compared with crops sown in the inter-row space.



**Figure 1. Canola sown on a water repellent soil on the old crop row on the left, and on the old inter-row on the right, in a farmer (Steve Waters) paddock at Calingiri, Western Australia.**

## **Materials and Methods**

### *Site details*

A site was chosen on a water repellent sandy gravel at 31° 8' 15.6"S, 116° 20' 42.0"E, near Calingiri, 150 km north-east of Perth, WA. Average annual rainfall at Calingiri is 422 mm, of which 323 mm falls in the May to October period.

Plots were established in a randomised block design with 4 replicates, including treatments of crops sown on the previous year's stubble rows, compared with crops sown in the inter-row spaces of the previous year's stubble. Plots were established in April 2012, and were 12 m long by 8.9 m (one seeder width) wide, with a row spacing of 0.18 m. Wheat was sown in May 2012, and barley was sown in June 2013, using a knife point seeder with trailing press wheels. Statistical analysis was performed by analysis of variance, and results were considered significant at the 5% level.

### *Crop measurements*

In both 2012 and 2013, crop emergence was assessed approximately three weeks after sowing. Seedlings were counted in two adjacent crop rows over a 1.0 m length, in nine locations, giving a total of 18 m of row length measured in each plot.

Crop yield was measured by harvesting three strips of 1.76 m wide (the plot header width) by 9.0 m long in each plot.

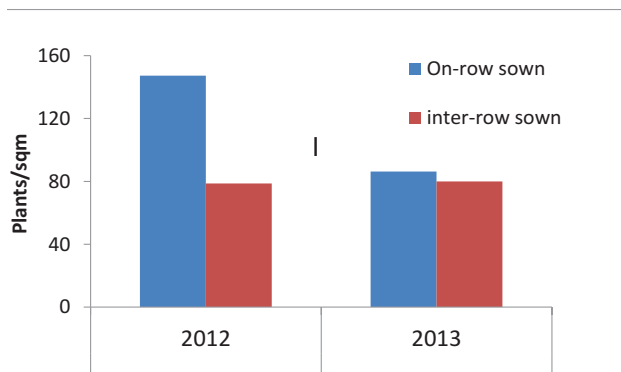
### *Water repellency measurement*

Soil samples were collected from the crop rows during August of both years from a depth of 0.0 to 0.05 m. Samples were dried at 105°C, returned to 20°C, and sieved to less than 2.0 mm to remove large organic matter and gravel. Water repellency was measured using the Molarity of Ethanol Droplet (MED) test (King 1981), where a value of 0 indicates a wettable soil, and greater than 3.0 indicates severely water repellent.

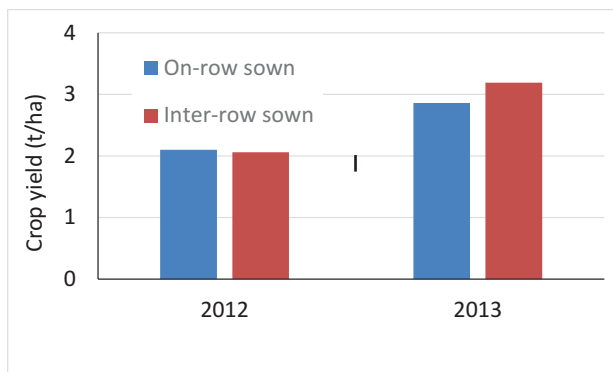
## **Results**

### *Crop emergence and yield*

In 2012, wheat emergence was significantly ( $p < 0.001$ ) greater when sown on the stubble row, compared with being sown in the inter-row (Figure 2). In 2013, there was no significant difference in barley emergence. Crop yield was not affected by row position in 2012 (Figure 3), but in 2013, barley sown in the inter-row position yielded significantly ( $p = 0.013$ ) more than crops sown on the old stubble row.



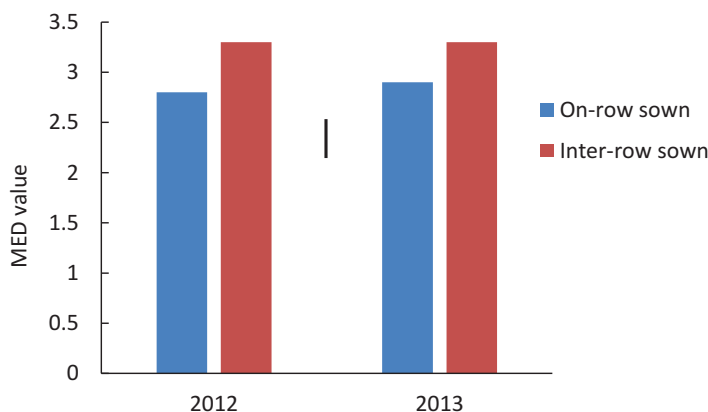
**Figure 2. Emergence counts for wheat (2012) and barley (2013) sown either on the old crop row, or in the inter-row position. Vertical bar represents the LSD value.**



**Figure 3. Crop yield (t/ha) for wheat (2012) and barley (2013) sown either on the old crop row, or in the inter-row position. Vertical bar represents LSD value.**

### *Soil water repellency*

Soil water repellency in the crop rows, as measured by the MED test, was significantly ( $p = 0.042$ ) less severe where crops were sown on the old row, than where crops were sown in the inter-row spaces (Figure 4), in both 2012 and 2013.



**Figure 4. Soil water repellence in the crop rows for crops sown either on the old crop row, or between the old crop rows. Vertical bar represents LSD value.**

### **Discussion**

The symptoms of water repellency (patchy and staggered crop germination) depend on the temporal patterns of rainfall at the break of the season, and so the expression of water repellency varies considerably from year to year. In our results, a substantial impact on crop emergence was observed in 2012, but not in 2013. Furthermore, in both years, seasonal conditions during later crop growth and grain filling were sufficiently mild to ensure that crops sown on the old crop row did not show a yield advantage. Indeed, in 2013, crops sown on the old crop row actually yielded less than crops sown in between the old rows, but in 2013, yields were influenced by a large ryegrass population, and so may not be representative of potential yields. Improvements in establishment in response to on-row seeding were also observed by Davies et al. (2012), but crop yields were not reported in this study. Therefore, although anecdotal evidence of improved yields with on-row seeding is compelling (Steve Waters, personal communication; Paul Hicks, personal communication), there is still no experimental evidence (of which we are aware) that confirms this.

Our results also demonstrate that soil in the crop rows shows lower levels of water repellency (as measured by the MED test) when crop rows are established on or close to previous crop rows, compared with crop rows established in the inter-row spaces. Where crops are grown on the previous crop row, there is likely to be greater organic matter and nutrient accumulation, which could encourage microbial activity. Furthermore, as shown by improved crop establishment, soil water is also likely to be more favourable for crop growth and microbial activity in on-row sown crops. As shown by Ward et al. (2013) and Roper et al. (2013), soil water contents in water repellent sand were greater in crop rows than in the inter-row spaces, and where residue

was retained. We speculate that improvements in soil water availability, and increases in organic matter, both associated with on-row seeding, might encourage microbial activity, leading to increased degradation of the compounds causing water repellency.

Water repellency causes significant losses in crop production, and management strategies vary from cheap (residue retention with no-till, minor changes to seeding boots, wetting agents) to expensive (clay addition, rotary spading, soil inversion). The most profitable management options will depend on the scale of water repellency on any farm (Blackwell et al., 2014). With the wide availability of 2 cm autosteer, on-row seeding may become an additional relatively low cost option for management of water repellency for crop production.

## Conclusions

On-row seeding, compared with inter-row seeding, was shown to increase crop establishment in one season, but not in another. There was no positive impact on crop yield. However, improvements in establishment, combined with observations suggesting decreased severity of water repellence in crop rows sown on the old crop row, suggest that on-row seeding may be a useful and low-cost option for management of water repellent soils for crop production. The implications of long-term use of on-row seeding on soil nutrition, organic matter, soil structure and soil-borne diseases on water repellent soils needs further research.

## Acknowledgements

Thanks to Steve Waters for sharing his observations of crop growth with us, for encouraging us to investigate crop row placement on his farm, and for accurately sowing the trial. Harvest measurements were performed by Kalyx. This research was funded by CSIRO and GRDC.

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