Managing water repellency with minimal soil disturbance

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Making water repellent soils more productive

**Change the repellent layer**
- Furrow sowing / Winged boots
- Surfactants – Banded wetting agents
- Microbial degradation of waxes

**Mix/invert the repellent layer**
- Claying (Kaolinite clays)
- Spading/Mouldboard ploughing

**Cropping systems that promote water infiltration**
- No-till systems
- On-row seeding
- Avoiding dry-seeding
Zero/No-till: Reduces erosion, but what effect on water repellency?

Retention of stubble can increase soil organic matter & *increase* soil water repellency.

*Anecdotal* evidence: water repellency “disappears” under zero-till & stubble retention.
Protocol

Treatments

- Zero/no-tillage vs cultivation (7-10 cm depth)
- Stubble retention vs stubble removal by burning

Measurements

- Patterns of water infiltration
- Soil water repellency (MED)
- Soil organic matter (total soil C)
- Seedling emergence
- Grain yield
Soil Carbon vs Water repellency

\[ R^2 \text{ (%C vs MED)} \text{ ranged from } 0.75 - 0.83 \]
Soil water content (0-12 cm) - %v/v
Plant emergence - canola

Stubble retained, no-till

Stubble burned, cultivated

Seedlings/ m²

<table>
<thead>
<tr>
<th></th>
<th>Retained</th>
<th>Burnt</th>
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<tbody>
<tr>
<td>NT</td>
<td><img src="image1.png" alt="Graph" /></td>
<td><img src="image2.png" alt="Graph" /></td>
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<tr>
<td>CT</td>
<td><img src="image3.png" alt="Graph" /></td>
<td><img src="image4.png" alt="Graph" /></td>
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Grain yield

Barley Yield

<table>
<thead>
<tr>
<th></th>
<th>Retained</th>
<th>Burnt</th>
</tr>
</thead>
<tbody>
<tr>
<td>NT</td>
<td>3.0</td>
<td>2.5</td>
</tr>
<tr>
<td>CT</td>
<td>3.5</td>
<td>3.0</td>
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</tbody>
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The graph shows the grain yield in t/ha for Retained and Burnt conditions. NT and CT likely refer to different treatments or management practices.
No-till: prior to seeding
Infiltration down old rows

Cultivated: day before seeding
No pathways for water movement

- No-till preserves biopores formed by roots that act as pathways for water infiltration.
- Cultivation destroys infiltration pathways.
July 2011 Zero-till – Infiltration down new & old rows
2012: all plots restored to zero-till & stubble retention
Soil carbon
4 seasons after restoration of no-tillage & stubble retention to all treatments: 2015 season
2016: 5 seasons after restoration of no-tillage & stubble retention to all treatments

- Retained - NT
- Retained - CT
- Burnt - NT
- Burnt - CT

Soil moisture (%v/v)

May 2016

Repellency (MED)

May 2016

Canola emergence

May 2016

Seedlings/ m²

May 2016
Crop yields 3-4 seasons after restoration of no-tillage & stubble retention to all treatments

Canola Yield 2014

Wheat Yield 2015

(2016: severe waterlogging- no yield data)
Recovery after re-introduction of zero-till & stubble retention

Cultivation → Zero/No-tillage
  • Rapid recovery (~12 months)

 Burning → Stubble retention
  • Greater than 5 years
On-row vs Inter-row seeding
Plant emergence after seeding

Sown on-row

Sown inter-row
Plant emergence after seeding

- **2012**
  - On-row sown: 160
  - Inter-row sown: 80

- **2013**
  - On-row sown: 80
  - Inter-row sown: 80

*Note: LSD P=0.05*
Yield differences

Canola sown on-row
1.5 t/ha

Canola sown on inter-row
0.2 t/ha

Photo credit: Steve Waters, Calingiri
On-row vs inter-row: Soil water content & water repellency
Soil microbes
Wax-degrading bacteria

Numbers of wax degrading bacteria
March 2015

Sample location
On-row
Inter-row

Log_{10} Numbers of wax-degrading bacteria

Nil
10^{-2}
10^{-3}
10^{-4}
10^{-5}
Dry seeding in water repellent soils?

Some growers find it makes repellency worse!
Left: Disturbed dry

Right: Un-disturbed
Seeded wet next day after 25 mm rain overnight

Seeded dry

Delay seeding to avoid making repellency worse

Photo credit: Steve Davies, DAFWA
Dry vs wet seeding- Pingrup

Yield

t/ha

<table>
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<tr>
<th></th>
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<th>wet sown</th>
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<tbody>
<tr>
<td>barley</td>
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<td></td>
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<tr>
<td>2015</td>
<td></td>
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<tr>
<td>2016</td>
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Pingrup 0.0 0.5 1.0 1.5 2.0 2.5 3.0
barley 2015 2016
Take-home messages

• Range of strategies to increase productivity of water repellent soils

• Cropping systems that promote water infiltration:
  - No/Zero-till with stubble retention
  - On-row seeding
  - Avoid dry seeding