Cereal and legume crop responses to deep-placed K with and without P in North-Eastern Australian Vertosols

David Lester, Mike Bell, Doug Sands, Tim Weaver
Acknowledgements
Structure

1. Context to the research
2. Hypothesis & Methodology
3. Results
4. Conclusions
NE Australia: Geography and Soils

Sub-regions of the Sub-tropical Cereal Belt

Geographic sub-regions
1. Atherton Tablelands
2. Central Highlands
3. Dawson-C Halifax
4. Inland Burdekin
5. Darling Downs
6. Liverpool Plains
7. Western Downs-Maranoa
8. North-west Slopes and Plains

Remainder of cereal belt

Cereal Soils of the Sub-tropics

Reference
- Black Vertisols
- Grey and Brown Vertisols
- Red, Brown and Black Chromosols/Sodosols
- Red Ferrosols
- Red Kandosols
- Lands unsuitable for cropping

Webb et al. (1997) Used by permission.

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Contrasting soil formation
Rainfall zones for Australia

Seasonal rainfall zones of Australia

Projection: Lambert conformal with standard parallels 10ºS, 40ºS.
Pan evaporation

Average pan evaporation
Annual

Projection: Lambert conformal with standard parallels 10°S, 40°S.

Based on at least 10 years of records from 1975 - 2005
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Department of Agriculture and Fisheries

Australian Government
Bureau of Meteorology
Growing conditions summary

- Soils with high water holding capacity (150-250 mm)
- Cropping driven by moisture storage
- High evaporative demand (annual 1800-2400 mm)
- Large growing season rainfall variability (annual rainfall 550-750 mm)
Profile Exch Cation Distribution

Kilcummin

Dysart

Jimbour West

Terry-hie-hie

Exch cations (cmol/kg)*

0.0 0.1 0.2 0.3 0.4 0.5 0.6

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* Ammonium acetate extractable
Profile Available P Distribution

Kilcummin
Col-P (mg/kg)

Dysart
Col-P (mg/kg)

Jimbour West
Col-P (mg/kg)

Terry-hie-hie
Col-P (mg/kg)

Soil depth increment (m)

0.0 0.1 0.2 0.3 0.4 0.5 0.6

0 10 20 30 40

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Hypothesis

More potential for immobile nutrient recovery if placed below 15 cm deep
Experimental treatments

- Untreated control “Farmer Reference”
- 0, 25, 50, 100 kg K/ha + 20 kg P/ha
- 0, 100 kg K/ha without P
- K as KCl; P as MAP
- Basal N, S and Zn (balanced)
- 0.20 +/- 0.05 m depth
- 0.5 m row spacing
- Applied early fallow; grower sown
Treatment applicator

MAP  KCl  Urea  S & Zn
Treatment position
Results

• Full details in proceedings (O301)
• 8 sites; 14 site years
• Contrast site overview here
**Dysart Yield results**

Treatment results are the change in yield from the FR treatment

<table>
<thead>
<tr>
<th>Year</th>
<th>FR</th>
<th>0K-P</th>
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<tr>
<td>13-14 Sg</td>
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**Year 1 Sorghum (2013-14):**

- Tillage &/or basal nutrient effect [FR vs 0K-P]
- No K effect without P [0K-P vs 100K-P]
- With P, K increase yield
Dysart Yield results

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**Year 2 Sorghum (2014-15):**
- Tillage &/or basal effect is diminished, No K effect without P
- With P (at depth), K increase yield (incremental effect)
### Dysart Yield results

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<td>15-16 Sg</td>
<td>2533</td>
<td>-31</td>
<td>68</td>
<td>108</td>
<td>447</td>
<td>271</td>
<td>197</td>
<td>290</td>
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**Year 1 Sorghum (2013-14):**
- Tillage &/or basal nutrient effect [FR vs 0K-P ]
- No K effect without P [0K-P vs 100K-P]
- With P, K increase yield

**Year 2 Sorghum (2014-15):**
- Tillage &/or basal effect is diminished, No K effect without P
- With P (at depth), K increase yield (incremental effect)

**Year 3 Sorghum (2015-16):**
- All effects diminished
- Site ran out of nitrogen
# Dysart K uptake (kg K/ha)

<table>
<thead>
<tr>
<th>Year</th>
<th>FR</th>
<th>OK-P</th>
<th>100K-P</th>
<th>OK+P</th>
<th>25K+P</th>
<th>50K+P</th>
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<tr>
<td>13-14 Sg</td>
<td>50</td>
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<td>73</td>
<td>55</td>
<td></td>
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<td>82</td>
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Kilcummin

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<tr>
<td>15 Cp</td>
<td>1765</td>
<td>49</td>
<td>-7</td>
<td>391</td>
<td>414</td>
<td>532</td>
<td>577</td>
<td>130</td>
</tr>
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</table>

**Year 1 (Chickpea):**
- No Tillage &/or basal nutrient effect
- No K effect without P
- With P (at depth), K increase yield (incremental effect)
Terry-hie-hie

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<tr>
<th>Year</th>
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<td>118</td>
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<td>80</td>
<td>128</td>
<td>176</td>
<td>38</td>
</tr>
<tr>
<td>15 Wh</td>
<td>4167</td>
<td>148</td>
<td>106</td>
<td>-88</td>
<td>131</td>
<td>50</td>
<td>31</td>
<td>NS</td>
</tr>
</tbody>
</table>

**Year 1 (Cotton):**
- No Tillage &/or basal nutrient effect, or P effect
- K increase yield, but very drought affected crop

**Year 2 (Wheat):**
- Better than average growing season
- No effect to any treatment
- More southerly growing zone
Conclusions

For high evaporative, stored moisture systems:

• Yield can be increased through deep co-location of K and P, but
• Site x season x species interaction
• Other nutrient constraints (N)
• Work continuing to explore these.