Getting Nitrogen into the crop – efficiently and effectively

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Better Crops, Better Environment ... through Science

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Efficiency and Effectiveness

Question
Where is the highest efficiency? A-B, B-C, C-D or >D?

- A-B 5 kg get 2.5 t/ha
  - 0.50 t/kg (0.4 t/kg)
- B-C 10 kg gets 3.5 t/ha
  - 0.35 t/kg (0.2 t/kg)
- C-D 15 kg gets 4 t/ha
  - 0.27 t/kg (0.1 t/kg)
- >D – 20 kg gets 4 t/ha
  - 0.0 t/kg (0.0 t/kg)

• Efficiency is important
• Effectiveness in more important – getting close to the potential - $/$
How does your farm line up?

- Every farmer/advisor knows of WUE 20 kg/ha/mm
- What is the nitrogen use efficiency?
  - Partial Factor Productivity
    - kg grain divided by kg N
  - Partial Nutrient Balance
    - kg N removed divided by kg N applied
    - Yield*Protein%/0.571

<table>
<thead>
<tr>
<th>Region</th>
<th>Cereal PFP kg grain / kg N</th>
<th>Cereal PNB kg N / kg N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>52</td>
<td>0.82</td>
</tr>
<tr>
<td>North America</td>
<td>45</td>
<td>0.68</td>
</tr>
<tr>
<td>SS Africa</td>
<td>123</td>
<td>1.89</td>
</tr>
<tr>
<td>East Asia</td>
<td>32</td>
<td>0.46</td>
</tr>
<tr>
<td>World</td>
<td>44</td>
<td>0.66</td>
</tr>
</tbody>
</table>
Address the limiting factor......

But I put on a 100 kg of nitrogen........

The soil was too damn acid!!

• What is limiting production?
  – Until that is addressed – there is no extra response.
  – Weeds, disease, cold, heat, etc.
  – For soils – how do you know?

ASPAC FERTCARE®
You get nothing for nothing…….

If produce is removed, nutrients go with it – if not replaced, then the soil reserves go down.

This is soil not the “magic pudding”.
Have a target –

to estimate a N demand

\[ N \text{ demand} = (\text{Yield} \times 22 \times \text{NUE}) - N_{pre} - N_{min} + N_{imm} \]

5 t/ha wheat crop?
The Process – Take a tactical view

Sowing
- Low N
- Average or better season

Tillering/SE
- Poor season Maybe?
- Average or better season

Stem Elong/FF
- Poor season - No action
- Average season – Top Up
- Good season – Maybe Not
- Poor season - No action
- Average season – Top Up
- Good season – Go for it!? 

Increased certainty of the season
Effective and efficient use of N in-crop

• Just like everything

• **TIMING IS IMPORTANT**

• Place – soil and/or foliar

• Source – UAN, GrUrea, SUrea, (AmS).

• Rate – to meet the unfolding potential (50 to 100 kg N/ha)

  20 mm rain equals 1 t/ha which demands about 40 kg N
Yield = Grain number * Grain weight
Grain number = heads * grains/head

Slafer et al 2014
Critical times for stress impacts on grain number

Grain number is defined between DC31 and 10 days after flowering

V Sadras, SARDI
At DC31 or so............

Probably around 50-80 kg N used up

- time to review and revise
How do you know if there is more N needed?

- Yield potentials
- N-rich strips in paddocks
- Plant testing
- NDVI *near or far*
- Looking!!
Intervention Options
GRDC – N timing*form*rate 2013
Trial Locations

0, 25, 50 kg/ha N
DC32, DC39, DC55, DC70
UAN, GrUrea, SUrea.
8 sites across HRZ, report on 3 from Victoria
Site Differences: Mean of all rate, time and source.

<table>
<thead>
<tr>
<th>Site</th>
<th>Yield</th>
<th>Protein</th>
<th>N Rem</th>
<th>Weights</th>
<th>Screenings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inverleigh</td>
<td>5.13</td>
<td>10.6</td>
<td>114</td>
<td>76</td>
<td>13.1</td>
</tr>
<tr>
<td>Murnong</td>
<td>4.49</td>
<td>7.9</td>
<td>62</td>
<td>74</td>
<td>6.6</td>
</tr>
<tr>
<td>Westmere</td>
<td>5.38</td>
<td>11.2</td>
<td>107</td>
<td>76</td>
<td>2.5</td>
</tr>
<tr>
<td>Sign</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Treatments</td>
<td>*</td>
<td>**</td>
<td>**</td>
<td>*</td>
<td>ns</td>
</tr>
<tr>
<td>Site*Tment</td>
<td>ns</td>
<td>*</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
</tbody>
</table>

Each site had N up to GS32 – 50 to 120 kg N/ha

Screenings @ Inverleigh ?Stripe rust?

Murnong – 4.5 t/ha – 8% protein – hmmmmm?
N response in yield and protein

Figure 1 Grain yield (t/ha) and protein concentration (%) from 10 wheat varieties with 0, 30, 60, 90 and 120 kg/ha applied nitrogen in a trial at Parkes in 2011. (Gardner and McMullen, 2012, http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2012/04/Comparison-of-grain-yield-and-grain-protein-concentration-of-commercial-wheat-varieties)
Protein as an indicators of missed yield

http://landresources.montana.edu/FertilizerFacts/21_PostHarvest_Evaluation.htm
Effect of timing – mean of all sites, rate and source.

<table>
<thead>
<tr>
<th>Time</th>
<th>Yield</th>
<th>Protein</th>
<th>N Rem</th>
<th>Weights</th>
<th>Screens</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC32</td>
<td>5.54</td>
<td>9.9</td>
<td>97</td>
<td>76</td>
<td>7.8</td>
</tr>
<tr>
<td>DC39</td>
<td>5.43</td>
<td>9.9</td>
<td>95</td>
<td>75</td>
<td>7.2</td>
</tr>
<tr>
<td>DC55</td>
<td>5.33</td>
<td>10.3</td>
<td>97</td>
<td>76</td>
<td>7.2</td>
</tr>
<tr>
<td>DC70</td>
<td>5.07</td>
<td>9.8</td>
<td>88</td>
<td>75</td>
<td>7.3</td>
</tr>
<tr>
<td>Sign</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>ns</td>
<td>ns</td>
</tr>
</tbody>
</table>

Early N = Yield – window is from DC32 to DC39

Late N = Protein – window is DC55 but before DC70
Similar experiment @ Longerenong

<table>
<thead>
<tr>
<th>Responses</th>
<th>Nil N</th>
<th>DC31</th>
<th>DC42</th>
<th>DC65</th>
<th>DC72</th>
<th>LSD p&gt;0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield (t/ha)</td>
<td>3.31</td>
<td>3.94</td>
<td>3.23</td>
<td>3.29</td>
<td>3.14</td>
<td>0.31</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>8.6</td>
<td>9.4</td>
<td>10.4</td>
<td>9.8</td>
<td>8.9</td>
<td>0.4</td>
</tr>
<tr>
<td>N recovered (kg N/ha)</td>
<td>50</td>
<td>65</td>
<td>59</td>
<td>57</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>% Recovery</td>
<td>75%</td>
<td>44%</td>
<td>33%</td>
<td>-4%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- 20 kg N/ha applied at various times
- Yitpi
- Mean of several forms
Summary of where to put your N dollar:

- sowing to stem elongation
- stem elongation to flowering
- after flowering

V Sadras, SARDI
Foliar, soil or what??

- N is taken up through the leaves
  - Urea > ammonium > nitrate
- Limited by either urea toxicity, salt burn or leaf area.
- Timing is important
- Worst effect if flag leaf is damaged
- The amount taken up through leaves is probably 10-15 kg N/ha
- Rest is taken up through roots.
- Leaf and soil – amm. loss.
Source*Timing – significant interaction for protein (not yield). For mean of 3 sites and 25/50 N rates

<table>
<thead>
<tr>
<th>Source</th>
<th>DC32</th>
<th>DC39</th>
<th>DC55</th>
<th>DC70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea-S</td>
<td>10.2</td>
<td>10.1</td>
<td>10.3</td>
<td>9.6</td>
</tr>
<tr>
<td>Urea-L</td>
<td>9.7</td>
<td>9.8</td>
<td>10.3</td>
<td>10.0</td>
</tr>
<tr>
<td>UAN</td>
<td>9.8</td>
<td>9.9</td>
<td>10.0</td>
<td>9.9</td>
</tr>
<tr>
<td>LSD</td>
<td></td>
<td></td>
<td>0.2</td>
<td></td>
</tr>
</tbody>
</table>
Early use of fluids v granules

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plant N 4 DAA (kg/ha)</th>
<th>Plant N 10 DAA (kg/ha)</th>
<th>Total Plant N at Anthesis (kg/ha)</th>
<th>Yield (t/ha)</th>
<th>Protein (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UAN streaming nozzles</td>
<td>23</td>
<td>30</td>
<td>30</td>
<td>1.54</td>
<td>9.6</td>
</tr>
<tr>
<td>Urea top dressed</td>
<td>19</td>
<td>26</td>
<td>30</td>
<td>1.69</td>
<td>8.5</td>
</tr>
<tr>
<td>UAN inter-row only</td>
<td>19</td>
<td>25</td>
<td>27</td>
<td>1.50</td>
<td>8.7</td>
</tr>
<tr>
<td>UAN standard nozzles</td>
<td>22</td>
<td>25</td>
<td>24</td>
<td>1.51</td>
<td>8.6</td>
</tr>
<tr>
<td>Liquid Urea</td>
<td>20</td>
<td>31</td>
<td>17</td>
<td>1.26</td>
<td>8.9</td>
</tr>
<tr>
<td><strong>LSD (P=0.05)</strong></td>
<td><strong>NS</strong></td>
<td><strong>NS</strong></td>
<td><strong>8.4</strong></td>
<td><strong>NS</strong></td>
<td><strong>0.11</strong></td>
</tr>
</tbody>
</table>

Applied at DC32 – low crop cover, N stress
Rain treatment – follow-up rain + 12% yield, -0.3% protein

BCG – T McClelland
Right Product

• Losses from Urea top dressed – 10% (Turner et al. 2010)
• Loss reduced to 1% with NBPT

• Losses 8-10%
  – Rain >7 mm 50% reduction
  – Bury to 5 cm – 75% reduction
  – NBPT – 90% reduction
  – Polymner coating – 50-98%
  – UAN – 30% reduction (half of the N is urea) (Bishop and Manning, 2011)

• Degree of loss depends on conditions after spreading!
Some take aways

• How good is your N management?
  – Grain Protein – did you leave yield on the table
  – What PFP and PNB did you achieve

• Invest in N between DC31 and DC55 as yield is king

• Late N to change grades is an option but luck is needed.

• There would need to be compelling circumstances to justify moving away from top-dressed urea, provided as the season unfolds.

• Operation successful – but the patient died
So where now with nitrogen:

part science and a punt on the seasons.