The practicalities of using Controlled Release Fertilisers

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Outline

• Overview of enhanced efficiency fertilisers
• Why CRFs for sugarcane?
• Independent assessment: existing CRF attributes

Things to take home

- Understanding of various types of enhanced efficiency fertilisers.
- How CRFs can assist Ag industry with environmental pressures
- Industry consider the need for quality control around CRF attributes
Enhanced efficiency fertilisers (EEF)

Use of enhanced efficiency fertilisers to increase fertiliser nitrogen use efficiency in sugarcane


Available from SRA website

Enhanced efficiency fertilisers

Stabilised fertilisers  Slow & controlled release fertilisers

Urease inhibitors  Nitrification inhibitors  Slow solubility or decomposition  Coated fertilisers

Keep in urea form  Keep in NH₄ form  Release N slowly to better synchronise with crop N uptake

Keep labile N low - Reduce N loss – Increase N uptake
Experimental evidence Australian sugarcane

• Some statistically significant positive effects
  • Wang et al. (2012), Dowie (2013a), Di Bella et al. (2013, 2014)
• Others not statistically significant
  • But quite a few with positive yield increases
    • Dowie (2013a), Salter et al. (2013), Farmacist (2013), Wang et al. (2014)
• Lack of N response, below average rainfall, spatial variability
• Benefits: where, when and why?
Understanding N demand

- Experimental N uptake data (Keating et al. 1999)
- Season-to-season variation?

- Root N requirements TBC

Synchrony
Slow or Controlled Release Fertilisers

• Many available globally

• Definition (European standardisation committee)
  • No official difference between slow and controlled release.
  • When testing at 25 °C, slow release:
    – No more than 15% released in 24 hours
    – No more than 75% released in 28 days
    – Around 75% released at the stated release time.

• How can we best use them?

Fertilisers

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Distributor / Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agrocote-S</td>
<td>ICL Specialty Fertilisers</td>
</tr>
<tr>
<td>Agrocote Emax</td>
<td>ICL Specialty Fertilisers</td>
</tr>
<tr>
<td>Agromaster</td>
<td></td>
</tr>
<tr>
<td>ESN</td>
<td>Landmark (Australia) Agrium (Globally)</td>
</tr>
<tr>
<td>Kingenta</td>
<td>Incitec Pivot Ltd.</td>
</tr>
<tr>
<td>IPL PSCU</td>
<td>Incitec Pivot Ltd.</td>
</tr>
<tr>
<td>Meister</td>
<td>Yates (Australia); Arysta (Globally). Produced by Chisso-Asahi Fertiliser Co.</td>
</tr>
<tr>
<td>Multicote</td>
<td>Haifa</td>
</tr>
<tr>
<td>Sumitomo</td>
<td>Summit Fertilizers</td>
</tr>
</tbody>
</table>
Attributes of CRF products

- Different “patterns” result from CRFs being constructed in different ways

- Materials science characterisations → provide a deeper understanding of the reasons for varied N release patterns.

- Link CRF patterns to APSIM models for N crop demand and environmental N loss.

Activities
Seek to understand release patterns & Why?

Leaching columns in incubator

Intact & disturbed cores with controlled suction

Coating characterisation performance & degradation/failure

Field measurement in collaborator trials
General properties observed
• Classified into Three “Types” of release patterns:
  I. >10% of population releases all urea in granule within 24 hr at 25°C.
  II. Linear (slow) release then depleted to form a parabolic pattern.
  III. Slow initial release, then increased rate to provide sigmoidal pattern.

Characterising N release
Rapid release due to coating failure

Summary of materials characterisations

<table>
<thead>
<tr>
<th>Type</th>
<th>Early failure (floating granules &lt; 5 days)</th>
<th>Early release (&lt; 1 day)</th>
<th>Susceptibility to damage</th>
<th>Microscopy</th>
<th>Granule size distribution</th>
<th>Dry Compression (Crush)</th>
<th>Wet compression</th>
<th>Granule wetting</th>
<th>Water uptake</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>&gt;10%</td>
<td>Increased</td>
<td>Limited attention to granule size</td>
<td>Low crush strength</td>
<td>Moderate rupture strength</td>
<td>Hydrophobic</td>
<td>Fast</td>
<td></td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>&lt;10%</td>
<td>Moderate</td>
<td></td>
<td>Moderate rupture strength</td>
<td>Fast-moderate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>&lt; 1%</td>
<td>Decreased</td>
<td>No damage</td>
<td>High crush strength</td>
<td>High rupture strength</td>
<td>Decrease hydrophobicity</td>
<td>Slow</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Test not applicable to sulfur-coatings
Modelling – connection to field

- Application of Type II fertiliser at 100 days
- Good match between actual release vs modelled release

Blending to manage Cost and Risk
Summary

• Overview of Enhanced efficiency fertilisers (EEFs)
• Lack of statistically significant response can be linked to:
  – Lack of N response
  – Spatial variability
• Synchrony:- crop N requirements and existing CRF products
• Classified CRFs into three general types
  I. >10% of population releases all urea in granule within 24 hr at 25°C.
  II. Linear (slow) release then depleted to form a parabolic pattern.
  III. Slow initial release, then increased rate to provide sigmoidal pattern.

Conclusion and next steps

• CRF can ‘in principle’ provide benefits
• Effectiveness of CRF still requires in-field trials
  • Industry assistance in further experimentation is required
• Modelling to elucidate CRF and N response
  • Yield/N loss benefits of CRF as a function of climate x soil x management interactions
  • Economics
• Industry to consider the need for quality control around CRF attributes?
  • Defects
  • Hydrophobicity? Degradability of coatings?
Thank you

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Colorimetric testing (after 1 day)

Type I ——— Increased coating thickness ——— Type II

Type II

Type III ——— Increased coating thickness ——— Type II
Rapid failure

- Data to date shows some products have consistently high early failure rates.

Compression testing
Moisture uptake (99%RH)