The importance of Sulphur in a balanced fertilizer strategy

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Contents

- Sulphur as a crop nutrient
  - Key functions in plants
  - The Sulphur cycle
  - Sulphur requirements of crops
  - Sulphur in decline
- Moving towards 2020
  - S in fertilisers and manures
  - S deficiency
  - S research
Sulphur - Introduction

- What is Sulphur
  - Non-metallic element, symbol S
  - Behaves similarly to Nitrogen
  - Requirement by most crops similar to P
  - Awareness increasing but slowly
  - Depositions decreasing – increasing need
  - No environmental impact
  - Diverse source of raw materials
  - Need determined by foliar test and/or requirement

Sulphur – Functions of S

- Key roles in plants
  - Key component of amino acids (and therefore protein)
  - Involved in production of oils and flavour compounds
  - Important for quality proteins (loaf and malting quality)
  - Required whenever N is converted into dry matter
  - Useful fungicidal / insecticidal properties
The Building Blocks for Performance...

The Sulphur cycle

**Inputs**
- Fertilizer
- Atmosphere
- Irrigation
- Weathering

**Recycling**
- Plant S
- Livestock and soil biota S
- Available S
- Labile organic S
- Inorganic S
- Resistant organic S

**Losses**
- Products
- Volatilization
- Leaching
- Immobilization

TII (IFA), 2010
Crop removal

<table>
<thead>
<tr>
<th>Crop type</th>
<th>Sulphur offtake (kg S per tonne yield)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Harvested fraction</td>
</tr>
<tr>
<td>Grass silage</td>
<td>2 (/t DM)</td>
</tr>
<tr>
<td>Winter wheat</td>
<td>1.2</td>
</tr>
<tr>
<td>Spring Barley</td>
<td>1.1</td>
</tr>
<tr>
<td>Beet</td>
<td>0.3</td>
</tr>
<tr>
<td>Oilseed rape</td>
<td>5.5</td>
</tr>
<tr>
<td>Potatoes</td>
<td>0.3</td>
</tr>
</tbody>
</table>

LFL, 2010 - Germany

Changing fertilizer trends

<table>
<thead>
<tr>
<th>Year</th>
<th>N use</th>
<th>P use</th>
<th>N from NH₄ SO₄</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>500</td>
<td>0</td>
<td>200</td>
</tr>
<tr>
<td>1999</td>
<td>550</td>
<td>0</td>
<td>250</td>
</tr>
<tr>
<td>2000</td>
<td>450</td>
<td>0</td>
<td>200</td>
</tr>
<tr>
<td>2001</td>
<td>400</td>
<td>0</td>
<td>150</td>
</tr>
<tr>
<td>2002</td>
<td>350</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>2003</td>
<td>300</td>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>2004</td>
<td>250</td>
<td>0</td>
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</tr>
<tr>
<td>2005</td>
<td>200</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2006</td>
<td>150</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2007</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2008</td>
<td>50</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Teagasc 2010 and FAO stat 2009
FAI 2012
Atmospheric sulphur: a burning global issue?

- Global SO2 emissions stable
- Shift in production
- China biggest producer
- North Atlantic fell dramatically

Sulphur emissions

Norwegian Met. Institute
Sulphur deposition 1-3.5 kg S/yr

Norwegian Met. Institute

Emissions and deposition - Ireland

Total S deposition and Emissions, Ireland 1990-2007

Norwegian Met. Institute
Sulphur risk – Ireland, 2000

Sulphur – S response in crops

Sulphur in winter wheat

(Bridgets, 1995)
Sulphur and N efficiency

N fertilization 185 kg N/ha

K fertilization in kg K₂O/ha

N removal in kg N/ha

- 57%
- 63%
- 64%
- 74%
- 82%
- 85%

Sulphur sources - bagged

<table>
<thead>
<tr>
<th>Bagged fertilisers</th>
<th>% S content</th>
<th>form</th>
<th>availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASN</td>
<td>13</td>
<td>Sulphate</td>
<td>Fast</td>
</tr>
<tr>
<td>Ammonium sulphate</td>
<td>24</td>
<td>Sulphate</td>
<td>Fast</td>
</tr>
<tr>
<td>Sulphate of potash</td>
<td>18</td>
<td>Sulphate</td>
<td>Fast</td>
</tr>
<tr>
<td>Kieserite</td>
<td>20</td>
<td>Sulphate</td>
<td>Fast</td>
</tr>
<tr>
<td>Elemental S</td>
<td>80-90</td>
<td>Elemental S</td>
<td>Slow</td>
</tr>
<tr>
<td>Epsom salt</td>
<td>13</td>
<td>Sulphate</td>
<td>Immediate</td>
</tr>
</tbody>
</table>
**Sulphur sources - manures**

<table>
<thead>
<tr>
<th>Organic manures</th>
<th>Total S kg/m3/t</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle slurry (6% DM)</td>
<td>0.28</td>
<td></td>
</tr>
<tr>
<td>FYM (25% DM)</td>
<td>0.96</td>
<td>Slow (1-3 years ?)</td>
</tr>
<tr>
<td>Pig slurry (4% DM)</td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td>Dirty water</td>
<td>0.04</td>
<td></td>
</tr>
</tbody>
</table>

- Storage conditions
- Age of manure
- Animal diet

**Sulphur – S recommendations - Ireland**

<table>
<thead>
<tr>
<th>Crop</th>
<th>Kg S/ha</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-cut silage</td>
<td>20 per cut</td>
<td>Same time as N</td>
</tr>
<tr>
<td>Grazed grass</td>
<td>20</td>
<td>As above</td>
</tr>
<tr>
<td>Cereals</td>
<td>15</td>
<td>Early spring</td>
</tr>
<tr>
<td>Swedes/turnips</td>
<td>25</td>
<td>Early growth stage</td>
</tr>
<tr>
<td>OSR</td>
<td>25</td>
<td>Split between early and mid spring</td>
</tr>
<tr>
<td>Beet</td>
<td>20</td>
<td>Late spring</td>
</tr>
</tbody>
</table>
Sulphur – S deficiency

- High risk situations
  - Sandy soils
  - Particularly rural areas
  - High rainfall areas
  - High use of straight N fertilisers
  - Highly responsive crops (oilseeds, milling wheat, silage etc)
  - Confirmed by leaf analysis

Sulphur for silage leys

- Key points
  - BSFP found just 12% of silage received S (5% all grass)
  - Average appl. Rate of 12 kg S/ha (5 kg all grass)
  - Shortage of S + high N gives free nitrates in grass
  - Legumes fix N but not S!
  - Indicated by DM content of <0.2 in grass
  - N:S ratio should be less than 15:1
  - Particularly common in 2nd cut silage
  - Younger leaves affected
  - General diffuse chlorosis (yellowing)
  - Consider sulphate / malate test in tillage crops
Recent research - grassland

- Ireland
  - 140 trials 1970 - 2002
  - 50% with significant yield response
  - Mean yield response 15%

- Wales (IGER) 2000
  - 4 silage response trials
  - Range of soil types
  - Mean annual yield increase
    - Sandy soil: 35%
    - Clay loam: 11% (no effect on 1st cut)
  - Increase in WSC and true protein

Sulphur – costly deficiency in grass
**Sulphur – S response in wheat**

- **Key points**
  - 88 TAG / HGCA trials published 2007
  - Mean yield increase of 6% across all sites
  - Sites with significant response increased by 27%
  - Milling varieties had consistently higher protein

- **Most important criteria**
  - Soil type (sandy soils gave biggest increase)
  - Atmospheric deposition
  - Winter rainfall

**Sulphur – S deficiency in cereals**

- Zero Sulphur
- 25 kg S/ha
Sulphur – S deficiency in cereals

Younger leaves affected = S (YeS)
Older leaves affected = N (NO)

Winter barley
Winter oats
Winter wheat

Sulphur deficiency in winter OSR
Recent research – malting barley

- **Key points**
  - HGCA trials published 2005
  - 2 sites, 2 varieties, 2 years (8 results)
  - Yield response 0.2-1.2 t/ha
  - 5 of 8 statistically significant
  - 10-20 kg S/ha
  - Correlated with soil S (<5ppm most responsive)

- **Most important criteria**
  - Soil type (sandy soils gave biggest increase)
  - Soil analysis
  - Foliar testing (17:1 N/S ratio critical)
  - + Improved beer flavour!

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Sulphur – S decision making

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<tr>
<th>A</th>
<th>High Sulphur deposition sites</th>
<th>Over 15 kg/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Over Winter (Nov to Feb) Rainfall</td>
</tr>
<tr>
<td>Soil Texture</td>
<td>Low (&lt;175mm)</td>
<td>Medium (175 - 375mm)</td>
</tr>
<tr>
<td>Sandy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loams &amp; coarse silts</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>Clay, fine silts or Peat soils</td>
<td>Low</td>
<td></td>
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</tbody>
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<table>
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<th>B</th>
<th>Low Sulphur deposition sites</th>
<th>Under 15 kg/yr</th>
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Conclusions

- A satisfactory supply of sulphur is essential for high yielding, quality tillage crops and grass grown in Ireland
- Atmospheric sulphur deposition has reduced significantly and continues to do so
- The contribution to crop demand from deposition is now minimal and likely to equate to between 5-10% of crop demand
- Increased yields have a corresponding increased demand for sulphur
- Increased S demand can be met from mineralisation of organic S sources or by way of fertilisers with an S component
- More trials are required on the ground
- Decision support tool for Ireland?

End

Thankyou