The importance of sulphur in crop production

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Analysis: Meet our global fertilizer team

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- Juan von Gernet
  Team Leader
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  Consultant
- William Irwin
  Consultant
- Michael Mew
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Steering the Fertilizer Industry through Challenging Times
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Sulphur in crop production
Why is sulphur important now?
A changing crop mix…
How is the industry reacting?
Conclusion
Sulphur in crop production.

What role does sulphur play in the crop and soil?

• Incorporated into essential amino acids, proteins, oils and organic compounds.
• Critical in the early establishment of crops.
• Root nodulation and nitrogen fixation in legumes.
• Sulphur contributes to resistance of environmental stresses.
• Deficiency results in stunted early growth – associated yield losses.
• Sulphur is key to the flavour of onions!

Image: CanolaWatch.org

Sulphur deficiency in Canola (Rapeseed)
Sulphur in crop production.

Atmospheric Deposition (Acid Rain) → Sulphate \( \text{(SO}_4^{2-}) \) → Organic Sulphur (Mineralisation, Immobilization)

Manure → Crop Residue

Leaching → Sulphate \( \text{(SO}_4^{2-}) \) → Elemental Sulphur

\( \text{SO}_2 \) Capture

Fertilizer manufacturing
Agenda

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Why is sulphur important now?

Why is sulphur suddenly ‘the 4th nutrient’?

• Sulphur deficiency in cropping systems has not traditionally been a problem... But this is changing
  • Lower sulphur emissions (environmental regulations)
  • More high analysis fertilizers (less S containing fertilizers)
  • Greater cropping intensity (higher yields)

• These are creating a problem... And an opportunity for fertilizer producers to diversify their products
Steering the Fertilizer Industry through Challenging Times

Why is sulphur important now?

Lower sulphur emissions

• Environmental regulations introduced in the 1980’s in Europe and North America

• Developing world has taken steps to follow this example...

• But China has failed to restrict emissions as industrial growth has accelerated

Why is sulphur important now?

- Sulphate ($SO_4^{2-}$)
- Organic Sulphur
- Manure
- Crop Residue
- Elemental Sulphur
- Atmospheric Deposition (Acid Rain)
- Less sulphur from acid rain...

- Leaching
- Mineralisation
- Immobilisation
- Oxidation

- SO² Capture
- Fertilizer manufacturing
Why is sulphur important now?

More ‘high analysis’ fertilizer

- Supply of urea, DAP, MAP, MOP have all increased sharply.
- These have taken over from low analysis fertilizers like single super phosphate (SSP) and ammonium sulphate (AS)
- Less sulphur is being added to soils through fertilizer

Data: CRU, IFA

Non S Fert contains <2% S, incl urea, AN, CAN, DAP, MAP, TSP, MOP, NPK
S Fert incl AS, SSP, SOP
Why is sulphur important now?

Acid Rain

- Less sulphur from acid rain...

Fertilizer manufacturing

- SO\(^2\)- Capture

Manure

Crop Residue

Organic Sulphur

- Mineralisation
- Immobilization

Sulphate (SO\(_4^{2-}\))

- Leaching

Oxidation

Elemental Sulphur

- Less sulphur from fertilizer
Why is sulphur important now?

Crop expansion in the ‘Cerrado’ region

S demand highest on West Coast

30% of arable land S deficient, particularly south

S included in NBS scheme

Deficit

- <1m t S/year
- 1-5m t S/year
- >5m t S/year

Data: Plant nutrient sulphur—a review of nutrient balance, environmental impact and fertilizers. SP Ceccotti (1996)
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Intensive agriculture is altering the nutrient balance

- Higher yielding, shorter season crops are putting more pressure on soils.
- High S demand crops include: Brassica (rapeseed), bulbs (onions) and root vegetables
- Medium S demand crops include: cotton, coffee, sugarcane, grasses/pastures

Crop Yields: 1960 - 2015

- Wheat
- Corn
- Rice
- Soybeans
- Fruit & Veg
A changing crop mix

Demand fundamentals are driving rapeseed/canola area

- Rapeseed/canola has become an increasingly popular crop.
- Consumption of vegetable oils and biofuel is rising.
- Canada – relationship between AS demand and canola area.
A changing crop mix

Sulphur and canola in Canada

• Experiment on sulphur deficient soil in Canadian Prairies

• Formulation, application rate, timing and method of application all have an impact on Canola yield and oil content

• Yields optimized with 15–30kg S/hectare, using sulphate S at seeding.

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• And when N is kept constant...

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Conclusion
How is the industry reacting

Current sulphur fertilizers

- Gypsum – By-product
- Kieserite – Magnesium and Sulphur
- Ammonium Sulphate – By-product
- Ammonium Thiosulphate – Only used in North America fertigation systems
- SSP – On the way out...
- Potassium Sulphate (SOP) – Attracting huge interest
- Polysulphate (Polyhalite) – New product from North England

SOP value components*
How is the industry reacting

**Sulphur enhanced fertilizers**

- Fertilizer industry has recognised the need for sulphur
- Sulphur also has a value... Premium fertilizer products
- Incorporation of sulphate and elemental sulphur
- Products more expensive
- NP+S is developing quickly in the US, Brazil and Africa
- Sulphur needs to come in a package...

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The agricultural value of sulphur is increasing

• Sulphur is key early in the crop life cycle and is a critical element in crop biochemical processes

• More high analysis fertilizers and lower SO$_2$ emissions mean that sulphur deficiency is increasing

• S deficiency most prevalent in Asia, Africa and Latin America

• Sulphur hungry crops like rapeseed and soybeans are increasing in area

• The industry is beginning to recognise the value of S. More sulphur enhanced products are being released.
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