Transformations and fate of seed-placed sulfur fertilizers in Saskatchewan soils

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SPG Contributions	Project Status	Duration/Timeline of Project (Year to Year)	Co-funders	Total Project Cost
$40,738.33	Completed	April 2013 – March 2016	Saskatchewan Ministry of Agriculture – Agriculture Development Fund (ADF); Western Grains Research Foundation; Saskatchewan Canola Development Commission	$150,038.33

Project Description

To determine the forms and plant availability of sulfur formed over a period of weeks to months following application to soils under controlled environment and field conditions; to assess the interaction of sulfur placed in the soil in a band together with phosphorus fertilizer; to develop and employ novel methodology using the new SXRMB beamline at the Canadian Light Source.

The form of sulfur (S) fertilizer can influence its behavior and crop response. Field studies were conducted in 2013 and 2014 along with a growth chamber study to evaluate five sulfur fertilizer forms (ammonium-sulfate, ammonium-thiosulfate, gypsum, potassium-sulfate, and elemental-sulfur) applied in the seed-row with wheat, canola, and yellow peas, at 20 kg S ha-1 alone, and in combination with monammonium fertilizer (MAP) at 20 kg P2O5 ha-1, in Brown and Black Chernozem and Gray Luvisol Saskatchewan soils. The fate of fertilizer was evaluated by measuring soil available sulfate and phosphate in the seed-row, crop sulfur and phosphorus uptake, and grain yields. The soils used in the study were marginally deficient in sulfur

Outcome

Canola was most responsive to the sulfur fertilizers, with limited response of wheat and pea to S fertilization in the majority of cases. Sulfate and thiosulfate forms were effective in enhancing short-term soil available sulfate supplies in the seed-row, along with crop sulfur uptake and yield compared to the elemental-sulfur fertilizer form which releases sulfate slowly by oxidation. Gypsum maintained the highest seed-row sulfate concentrations over time, a consequence of its slightly soluble nature which reduced the sulfate leaching. Most of the S uptake occurred over the period from one to four weeks after seeding and fertilizing. Combination of sulfur fertilizer with MAP may provide some enhancement of phosphate availability, but effects were typically small. Using the Canadian Light Source (CLS) synchrotron, thiols and ester sulfates were identified as short-term products formed from seed-row placed sulfur fertilizers in prairie soils that likely originate from microbial immobilization of fertilizer sulfur. The CLS spectra provided some evidence of elemental S oxidation to sulfate occurring over time. XANES spectroscopy revealed that one week after fertilizer application, P species present in the seed-row included similar proportions of adsorbed and poorly crystalline phosphate forms in both Brown and Black Chernozem Saskatchewan soils. However, fertilization with sulfate was noted to increase the conversion from calcium phosphate to adsorbed phosphorus forms in the Brown soil.

Research Objective

OBJECTIVE 1
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OBJECTIVE 2
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OBJECTIVE 3
To develop and employ novel methodology using the new SXRMB beamline at the Canadian Light Source.