

Sulphur Deficiencies in Central British Columbia

INTRODUCTION

Sulphur deficiencies were first noted by Agriculture Canada's fertilizer research in the 1940s in Central British Columbia. The result of this initial and subsequent research has shown that many soils of this region are sulphur deficient.

Serious economic losses have occurred when crops have failed to respond to nitrogen fertilizer when soil sulphur levels were low. Knowledge of available soil sulphur levels is important in formulating appropriately balanced fertilizer blends that avoids crop failures.

SULPHUR IN THE SOIL

The main source of sulphur in Central B.C. is from the organic matter component of the soils.

The organic matter content of Central Interior soils is low and the supply of plant available sulphur often falls below required levels.

Sulphate minerals are not found within the upper metre of most soils in Central B.C., having been leached down over centuries of soil development. The drier southern regions of Central B.C. may have some local high concentrations of sulphate minerals that have come to the surface at seepages.

Fertilizing with sulphur and use of animal manures can improve the low soil sulphur levels to achieve adequate crop production levels.

SULPHUR DEFICIENCY SYMPTOMS AND FIELD CROP REQUIREMENTS

1. Deficiency Symptoms

Slight to moderate sulphur deficiencies are not easily detected by visual symptoms, but a crop yield reduction may occur. When visual symptoms are evident, it is an indication of a severe sulphur deficiency. Depending upon the crop's growth stage, corrective action by fertilizing with sulphur may prevent a total crop loss. A regular soil sampling program would alert producers to an impending sulphur deficiency without relying on visual symptoms. The visual symptoms of a sulphur deficiency are:

- a) **Alfalfa & Clovers**
 - stunted, thin spindly plants;
 - slow growth and delayed maturity;
 - initial light green of leaves progressing to yellow leaves and in severe cases, the whole plant becomes yellowish.
- b) **Grasses & Cereals**
 - delayed maturity;
 - new leaves yellow;
 - slow growth.
- c) **Canola**
 - yellowing on younger top leaves and under severe deficiencies progresses to entire plant;

- pink coloration on leaf undersides which progresses to purplish older leaf margins;
- pink or purplish stems;
- leaves may roll inwards and appear cupped;
- extended flowering period and poor seed set.

2. Crop Requirements

Crops vary in their efficiency of using available soil sulphur. Alfalfa and canola are less efficient in their sulphate uptake than cereals or grasses, and will show deficiencies at sulphur levels considered adequate for the other crops. When grasses and alfalfa are grown as a forage mix, marginal sulphur levels may allow an adequate yield of the grass component but result in a lower alfalfa yield.

Table 1 shows the recommended soil sulphur levels and fertilizer for field crops in the Central Interior.

Table 1

| Soil Sulphur Levels, Ratings, and Sulphur Fertilizer Recommendations | | | | |
|--|--------------------------------|---|-----------------|--------|
| Sulphur* Soil Test µg/ml (ppm) | Available Sulphur Rating | Recommended Sulphur Fertilizer Rates (kg/ha) | | |
| | | Grasses | Legumes | Canola |
| 0–10 | very low (VL) | 30 | 30 | 30 |
| 10–20 | low (L) | 20 | 20 ₊ | 20 |
| 20–25 | medium (M) | 10 | 10 ₊ | 20 |
| 25–35 | high (H) | 0 | 0 | 10 |
| Over 35 | very high (VH) | 0 | 0 | 0 |

* Using the “Kelowna Extract” – acetic acid-ammonium fluoride extractable sulphur.

+ For alfalfa, 10 kg/ha additional sulphur recommended to ensure adequate production levels and decrease the potential for winterkill damage.

SULPHUR FERTILIZERS

Fertilizers containing sulphur are available in two possible sulphur forms:

- (1) fertilizers as sulphate (SO₄) salts;
- (2) fertilizers containing elemental sulphur (S).

1. Sulphate Fertilizers

There are several sulphate-sulphur fertilizer sources. Ammonium sulphate (21-0-0) is the most commonly used source, either alone or blended with other fertilizers. Other sulphate bearing materials such as potassium sulphate (K₂SO₄) or gypsum (CaSO₄ – calcium sulphate), are not widely used in the Central Interior.

Sulphates can be leached and will move with water through soils. Coarse textured soils under irrigation or high precipitation will have more sulphate leaching than slow draining clay soils.

2. Elemental Sulphur Fertilizers

Elemental sulphur is converted to the sulphate-sulphur form by bacteria of the **Thiobacillus** family. The conversion rate is most rapid on warm, moist soils that have a large bacterial population. For the most rapid conversions, elemental sulphur should be incorporated into the soil. If these conditions are not met, crop responses to elemental sulphur fertilizers may be delayed and irregular.

The sulphur requirements of cereals have been met when elemental sulphur with a fine particle size has been incorporated into the top 10-15 cm prior to seeding, and occasionally, when top dressed on forage crops.

Elemental sulphur fertilizers can be used most appropriately when soil sulphur levels are to be maintained above deficient levels, and a crop response in the application year is not required or expected.

3. Liquid Sulphur Fertilizers

Ammonium thiosulphate (12-0-26S) is a liquid sulphur fertilizer. It also requires microbial action to convert it to plant available sulphates. However, the conversion rate is quicker after application, with 50% converted to sulphate, and the remainder as elemental sulphur. It is regarded as being nearly as effective as sulphate fertilizers at providing crop responses in the application year.

The use of liquid sulphur fertilizer has not been researched in Central British Columbia.

4. Residual Sulphur

Residual sulphur is unused sulphur fertilizer that remains available for the following year's crop. Forage crops in the Central Interior have responded to residual sulphur. This has occurred when 20 to 30 kg/ha sulphur was spring applied on clay soils, and the following growing season was dry. Sulphur usage by the crop was reduced by drought, and movement of sulphates to lower soil depths was not significant.

As an example, alfalfa has responded to 40 and 80 kg/ha rates of elemental sulphur for 4 to 5 years after this initial application.

Table 2

| Sulphate and Elemental Sulphur Fertilizers | | | | |
|---|------------------------|-------------------------------|------------------|-----|
| Product Name | Fertilizer Formulation | | | |
| | N | P ₂ O ₅ | K ₂ O | S |
| % | | | | |
| Sulphate Fertilizers | | | | |
| Ammonium Sulphate | 21 | 0 | 0 | 24 |
| Ammonium Phosphate-Sulphate | 16 | 20 | 0 | 14 |
| Ammonium Sulphate + Urea (blend) | 34 | 0 | 0 | 11 |
| Urea (solution) | 20 | 0 | 0 | 5 |
| *Ammonium Thiosulphate (solution) | 12 | 0 | 0 | 26 |
| Potassium Sulphate (granular) | 0 | 0 | 45(50) | 18 |
| *Calcium Sulphate (gypsum-granular) | 0 | 0 | 0 | 18 |
| Elemental Sulphur Fertilizers | | | | |
| Elemental Sulphur + Clay Mixes (Degrasul or Tiger-90) | 0 | 0 | 0 | 90 |
| Flowers of Sulphur | 0 | 0 | 0 | 99 |
| Urea Sul (Urea-S) | 36 | 0 | 0 | 20 |
| *Solid Sulphur Pellets | 0 | 0 | 0 | 100 |

* These products are not common in the Central Interior.

SOIL ACIDITY AND SULPHUR

Sulphur fertilizers have the potential to acidify soils. However, nitrogen fertilizers contribute most to soil acidification due to the volume used in comparison to sulphur fertilizers. Combined nitrogen and sulphur fertilizers are the most acidifying of all fertilizers. When nitrogen-sulphur fertilizers are used judiciously to meet crop's sulphur requirements, the amount of acidification is minimal, while the benefits from improved crop yield are large.

Sulphur should not be applied annually without testing the soil sulphur level through soil tests. Some soils in the Central Interior are acidic, and should only receive appropriate sulphur levels for crop production.

Table 3

| Sulphate Fertilizer Calculation Chart | | | | |
|---------------------------------------|---------|------------------------------------|-----|-----|
| Fertilizer | Sulphur | Sulphur Fertilizer Rate | | |
| | | Soil Test Recommendations | | |
| | | -----kg S/ha----- | | |
| | | 10 | 20 | 30 |
| | | Fertilizer Application Rate | | |
| | | -----kg/ha----- | | |
| | %S | | | |
| 21-0-1 | 24 | 42 | 83 | 125 |
| 16-20-0 | 14 | 71 | 143 | 214 |
| 34-0-0-11 | 11 | 91 | 182 | 273 |
| 13-16-10 | 12 | 83 | 167 | 250 |
| 10-30-10 | 5.0 | 200 | 400 | 600 |
| 26-13-0 | 3.9 | 256 | 513 | 769 |
| 8-24-24 | 3.2 | 313 | 625 | 938 |
| 20-0-0 | 5.0 | 200 | 400 | 600 |
| 0-0-45(50) | 18 | 55 | 111 | 167 |
| 36-0-0-20 | 20 | 50 | 100 | 150 |
| Gypsum | 18 | 55 | 111 | 167 |
| Degrasul/Tiger | 90 | 11 | 22 | 33 |
| Flowers of Sulphur | 99 | 10 | 20 | 30 |

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