Importance of Sulphur in crop production

By Dr. Tarlok Singh Sahota

Sulphur (S), the protein forming nutrient, is 9th in the row of 17 nutrients (including cobalt) essential for plant(s) growth and development. It also plays an important role in sugar production, especially in sweet corn. Ontario soils are said to be receiving sulphur (S) through acid precipitation. However, S deficiency has earlier been reported in sandy soils of northwest Ontario, and more and more soils are likely to run short of this nutrient due to (i) anti pollution regulations that have reduced sulphur dioxide emission from industry and (ii) increased use of S free fertilizers. In an earlier article, I had indicated that:

- In the last 10 years, deposition of Sulphur (S) has come down by 30-40 %.
- Environmental Protection Agency would require equipment emissions of S to be reduced by 90 % in the next 8 years.
- P fertilizers today contain much less S as compared to 20 years ago. Triple super phosphate, for instance, contains 1.5 % S, while DAP contains 2 % S as compared to 12 % in normal (single) super phosphate.
- Sulphate contains 33 % S, but the manure, with 8 % solids, contains only 3 lb S/1000 gallons.
- Forage analyses showed that S content in alfalfa, grasses and corn silage declined by 13, 13 and 29 % respectively in 11 years (1992-2003). Sooner or later farmers will therefore need to supplement S.

Sulphur imparts deep rich green colour to plant canopy, especially in alfalfa, and is taken by plants in sulphate (SO_4^{2-}) form. Sulphate is moderately susceptible to leaching in sandy soils, though not as much as nitrogen (N), due to formation of less soluble calcium sulphate in soils. Soil sampling for S is therefore recommended every year as is also the case with N. Sampling up to 30 or 60 cm soil depth is recommended. However, more than 95 % of soil S is bonded in organic forms in the upper layers of most soils and is not readily available to the plants. Soil test for S is therefore not considered to be as reliable as its tissue test. In cereals, whole plants prior to filling, 0.15-0.40 % S is sufficient, 0.1-0.15 % S is marginal and 0.1 % S is considered to be low. Cereal plants with excess S have concentration of 0.8 % S in them. Sulphur deficiency in wheat is possible if N: S ratio, on dry weight basis, is greater than 17:1. In alfalfa, which is known for its high S requirements, 0.20-0.50 % S in top 15 cm tissue at 5 % bloom is sufficient; anything below that range is low and anything above that range is high. At the bud stage, healthy alfalfa plants contain at least 0.2 % S. Alfalfa removes 5-7 pounds S per ton of its dry matter yield. PPI reports S removal of 40 lb/acre at 8 ton yield of alfalfa, 20 lb S/acre in barley (100 bu/acre) and corn (120 bu/acre), 10 lb S/acre in wheat (40 bu/acre), 8 lb S/acre in soybean (25 bu/acre), 30 lb S/acre in Bermuda grass (6 ton/acre) and 24 lb S/acre in Fescue (6 ton/acre). Canola too is one of the high S requiring crops. A healthy canola crop at early flowering will have more than 0.25 % S; plants with less than 0.20 % S are low in S. Its uptake in canola continues till full pod formation (major part between first flower to 50 % pods) as compared to N uptake, which almost ceases at 50 % flowering (lion's share at 5 leaves to 50 % flowering). Studies in USA indicated that normal tissue concentrations of S in legume, grass and corn silages were in the range of

0.21-0.24, 0.15-0.26 and 0.09 -0.12 %, respectively (Everett 2004). Thus legumes require more S than grasses and corn.

In S deficient plants, the entire shoot, especially the top half, looks pale green, though S deficiency can occur without expression of any visual symptoms. These symptoms are different from N deficiency symptoms (lower leaves first becoming pale green and then yellow). For cereals and forage grasses, yellowing of newly emerging leaves is a strong indicator of S deficiency. In canola, S deficiency leads to cupping and purpling of leaves. Sandy soils, low organic matter, no recent history of manure application make an ideal set up for S deficiency. Sulphur deficiency will be most likely on knolls and other well drained areas of the field. However, it appears that S deficiencies are occurring in many other soil and fertility management situations. For example, cool soil temperatures can restrict root development and reduce S availability leading to S deficiency in crops grown even on soils rich in S. Conservation tillage can keep the soils cool and S may be needed to stimulate early growth in this stressful period. *Alfalfa is the most commonly deficient field/forage crop in S. Deficiency of S can also result in N deficiency in alfalfa because S is required for health and functioning of N fixing nodules. When fed to livestock, S deficient forages can reduce animal performance.*

Without adequate S, crops can't reach their full potential in terms of yield, quality or protein content; nor can they make efficient use of applied N. Yield responses to applied S were first found, in Denmark, on second cut silage in the early 1980s. In the past two years, yield responses were recorded in winter wheat and first cut silage (1.04 tons dry matter/ha). A report from The Sulphur Institute, Washington, indicates that in one university field trial, a hay crop had failed to respond to 150 lbs N. But when the same crop was fertilized with 33 lbs S, the crop yield nearly tripled. Similar results are reported in wheat, corn and canola. Therefore, for sustainable crop yields, S application should form an integral part of the fertilizer program. Sulphur could be applied @ 10-20 kg/ha, preferably at seeding, through S containing fertilizers, but should be based on the soil/and tissue test. Application of S in canola could be made until the bolting stage. One recommendation is to apply 1 lb S for every 15 lb of N. Important S fertilizers are ammonium sulphate (24 % S), ammonium phosphate sulphate (14-15 % S), potassium sulphate (12 % S), ammonium thiosulphate solution (26 % S) and elemental S (90-99 % S). Ammonium sulphate or potassium sulphate should be preferred as sources of S to elemental S that takes 12-18 months to get converted in to the sulphate form in which it is readily available to crop plants. Sulphur from ammonium sulphate accelerates emergence and improves resistance to white mould in dry beans; it makes P and micronutrients more available in early planted cold soils (Greg Patterson). Beneficial effect of S from ammonium sulphate was also reported in snap beans, cabbage, potatoes and peas for processing. Wood ash is another readily available source of S at Thunder Bay. Ten tons of wood ash could supply up to 10 Kg S. Besides, wood ash will add not only other nutrients (especially K, P and Mn), but also improve availability of nutrients from the native soil sources because of its liming effect.

Since S plays an important role in protein synthesis, protein yield/acre could be significant with S application even if the forage yields were non-significant. Recent research at Michigan State University indicated that an investment of $6.25 (25lb S/acre @ $0.25/lb S) in fertilizer S returned an average of 0.40 tons of alfalfa (over 4 years), which based on $100/ton is worth $40. A 6 to 1 is a very nice return! In corn silage, even though application of S @ 46 lb/acre resulted only in insignificant increase in yield or tissue concentration of S, it improved the NDF-d by 6.7 % and consequently increased the milk yield (lb/ton) by 5.9 % and milk/acre by 1833 lbs (Everett 2004). *Thus the milk yield improvement from a 50 acre corn silage field supplied with S could be 91650 lbs or 41.5 tons. Another advantage would be that the soils will not be left poorer of S. After all each crop, with or without S application, will continue to mine S from the soil (Italics mine).* It may be worth mentioning that corn in Peter Aalbers and Kevin Belluz's fields that received S, as ammonium sulphate and potassium sulphate respectively, had dark green leaves from top to bottom. A pale canopy at the top could be a pointer to S deficiency. However, if there are pale or white stripes on the leaves that would indicate zinc deficiency.

In the end, quoting The Sulphur Institute, I may say," You may not have the time or equipment to fuss with scientific field trial, but leaving a check strip or putting out a few test plots will give you a glimpse of sulphur's impact on crop yield, quality and protein". For obtaining free of cost educational brochures on S, readers may email The Sulphur Institute at sulphur@sulphurinstitute.org.

Published in Ontario Farmer, Dec. 13, 2005, 38 (42), Page B25 and Northwest Link, September, 2006, Pages 10-12.