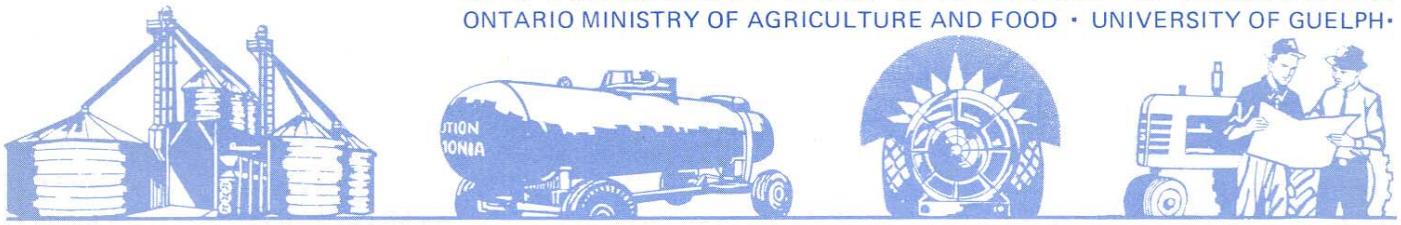
INFORMATION FOR INDUSTRY PERSONNEL
ONTARIO MINISTRY OF AGRICULTURE AND FOOD • UNIVERSITY OF GUELPH•



Source —

T. E. Bates and R. W. Sheard
Department of Land Resource Science
Ontario Agricultural College
University of Guelph

100 or 200
AGDEX NO. 540

Date September, 1988

Sulfur and Sulfate Fertilizers - Do we need them?

1. Plants do require sulfur.
2. In Ontario, the sulfur requirements of crops appear to be met by air pollution except in parts of Northwestern Ontario.
3. Field trials run by the University of Guelph with several crops have not shown sulfur response.
4. It is not practicable to lower the pH of alkaline soils (pH above 7.0) by adding sulfur, ammonium sulfate or aluminum sulfate.
5. In Ontario, soil pH values above 7.0 are very satisfactory for production of most field crops.

Do Plants Require Sulfur?

Yes! Sulfur is a part of the amino acids cystine and methionine and is therefore required for protein formation and hence for plant growth. Sulfur is also present in plant oils and is involved in enzyme activation. Many common crop plants contain approximately the same amount of sulfur as they do of phosphorus.

Ontario soils, like those of most areas with a plentiful moisture supply, are naturally low in sulfur and would respond to sulfur if the soil were the only source (2). In the 1880's gypsum or "land plaster' (calcium sulfate) was applied in Ontario as a fertilizer (1). Visible crop response to gypsum was reported at that time and the most likely reason for this is a need for sulfur. About 1880, superphosphate containing 12 to 14% sulfur came into use as a fertilizer in Ontario and over the next 70 years it became the standard source of phosphorus for all crops. The use of gypsum disappeared. The superphosphate at rates used apparently supplied sufficient sulfur for crops so that there was no longer a response to gypsum.

Since about 1950 more concentrated sources of phosphorus, chiefly ammonium phosphates and 46% superphosphate have almost completely replaced 20% superphosphate. These more concentrated phosphates contain very little sulfur.

You might expect that we would be short of sulfur again but with the exception of Northwestern Ontario where sulfur deficiency has been documented, various trials in the province have shown no response. A recent experiment with an alfalfa-grass mixture failed to show a yield response to a surface application of gypsum at any of three harvests (Table 1). The comprising 83% or more alfalfa, was not increased by gypsum. Alfalfa growing without gypsum contained 0.25% sulfur or greater which is similar to the accepted sufficiency level of 0.23 - 0.25% sulfur in leaf phosphorus concentration, were not increased by the gypsum applications.

Sulfur is Supplied by Air Pollution

Since the 1880's when gypsum was used we have had large increases in air pollution with sulfur dioxide and this apparently supplies sufficient sulfur for crop production in all of Ontario except the extreme northwest. In the Kingston area G.K. Rutherford (3) found an average of 28 kilograms of sulfur per hectare each year from rainwater. Because of air pollution sulfur deficiency does not pose a problem in the portions of the USA immediately south of us. Deficiency is reported in parts of Minnesota and Wisconsin west of the industrial cities. Sulfur deficiency also occurs in the northern part of the prairie provinces but infrequently in the drier southern parts where rainfall is insufficient to leach out the natural soil supply.

Should Sulfur be Used to Lower Soil pH?

Sulfur, aluminum sulfate and ammonium sulfate can be used to lower soil pH. In Ontario, the questions to be answered are whether lowering soil pH is necessary or profitable.

The average soil pH in Southern Ontario is approximately 6.8 and some soils do have pH values as high as 8.2. Most textbooks say that the ideal pH for nutrient availability is 6.5. Should we therefore lower the soil pH of the more all Wine soils? The textbooks are of necessity very general and there is no evidence that crops grow better on Ontario soils at pH 6.5 than at 7.5 or 8.0. Zinc and phosphorus are two nutrients whose availability is thought to be particularly dependent on soil pH. In a large number of corn samples from across Ontario the zinc content was not related to soil pH and zinc deficiencies have more often been found on soils with pH values below 7.0. Many of our high pH soils are very well supplied with phosphorus as shown by soil test by the phosphorus content of crops, and by the lack of response to applied phosphate fertilizer. Some textbooks say that the ideal soil pH for barley and alfalfa is 7.0 or above and even for corn the states of Ohio and Iowa have recommended liming to nearly pH 7.0. *Farmers with soil pH values above 7.0 in Ontario should not worry about lowering their soil pH for general field crops. They are actually fortunate because they do not need to apply lime and probably won't in this century.*

There are crops such as tobacco, potatoes, and ornamentals such as rhododendrons, which suffer from or nutritional problems at high pH. Is it practical to lower the pH of soils for production of acid requiring crops? Heeg and Richardson (4) applied 1120 kg of sulfur per hectare each year for three years to a fine sandy loam soil near Ancaster, Ontario with an original pH of 6.2. At the end of the fourth year the pH with sulfur was 5.2, 1.0 pH unit below that of the treatment without sulfur. Even on this sandy soil one and a half tons of sulfur were required to lower the soil pH one unit. On Ontario soils with pH values above 7.0 there is usually an appreciable supply of calcium and magnesium carbonates which must be neutralized before the pH will drop. At a pH of 7.0 loam soils in Ontario contain about 1% calcium and magnesium carbonate amounting to 9 metric tonnes of pure lime in the top 15 centimetres (1 kilogram of sulfur will compensate for 3 kilograms of lime). Soils of higher pH than 7.0 usually contain much more calcium and magnesium carbonates so it is usually *completely impractical to lower their ph with sulfur*. Soils with pH values of 6.8 or less are gradually becoming more acid, particularly where high rates of nitrogen fertilizers are used.

Nitrogen Fertilizers Make Soils Acid

Nitrogen fertilizers make soils more acid on a long term basis and it is sometimes suggested that ammonium sulfate should be used on alkaline soils as it has a greater acidifying effect than other nitrogen fertilizers.

Ammonium sulfate does have a greater effect (Table 2), and on soil with an initial pH below 7.0 it would lower the pH over a period of years. The extra cost of ammonium sulfate over that of more common nitrogen fertilizers makes its use impractical in most cases. *Where the soil pH is above 7.0, use of ammonium sulfate to lower soil ph is just as impractical as use of sulfur.* It is worth noting that anhydrous and aqua ammonia and urea make soils more acid over the years (Table 2) although they raise the pH quite markedly for a few days or weeks after application.

We occasionally hear that other sulfate fertilizers such as potassium sulfate have an acidifying effect. Potassium sulfate and magnesium sulfate do not normally make the soil more acid, having the same effect as muriate of potash in this regard (Table 2).

What About Gypsum?

Gypsum (calcium sulfate) can be used as a source of sulfur in parts of the world where sulfur is needed. In drier parts of the world some soils are high in sodium, a condition which is not know to occur on agricultural soils in Ontario. High sodium soils often have serious structural problems or develop them when irrigated and cropped. Calcium sulfate is commonly added to these soils and aids markedly in their reclamation by replacing the sodium with calcium. *Ontario soils are not high in sodium and contain an abundance of calcium so that calcium sulfate additions for this purpose are neither effective nor necessary*.

We also occasionally hear that some of our high pH soils are low in available calcium. Many are actually very high in available calcium and will remain so for many years.

The need for lime to make soils less acid is increasing and is a much more important concern for Ontario farmers than trying to make our many high pH soils more acid.

Literature Cited

1. Ontario Agricultural Commission Report, Appendix N, 1881.

2. Sheard, R.W. Sulfur responses on Ontario soils. Jour. Sulfur Institute 12: No. 1, 1976.

3. Rutherford, G.K. 1967. A preliminary study of the composition of precipitation in S.E. Ontario. Can. 1. Earth Sci. 4: 1151-1160.

4. Heeg, TJ. and J.K. Richardson, 1958. Potato common scab investigations 11, American Potato Jour. 35 (9): 662-675.

TABLE 1: Dry matter yield obtained from increasing rates of sulphur applied to the soil surface of an alfalfa-grass stand.

	Rate of Sulphur				
Cut	0	30*	0	90	Legume
			(tonne dry wt/ha)**		
1	4.29	4.63	4.54	4.58	73
2	3.02	2.85	2.70	2.77	88
3	2.11	1.82	1.73	1.99	83
Total	9.42	9.30	8.97	9.34	

*30 kg S/ha is equivalent to 167 kg gypsum/ha.
**mean of six replications.

TABLE 2: Lime required to neutralize the long-term acidifying effect of fertilizers*.

Material	Nutrient	Kilograms of lime required to neutralize one kilogram of nutrient
Anhydrous ammonia	82% N	1.8
Aqua ammonia	20% N	1.8
Ammonium nitrate	33.5%N	1.8
Urea	46% N	1.8
Ammonium sulphate	20.5%N	5.4
Muriate of potash	60% K_2O	0
Sulphate of potash	50% K_2O	0
20% superphosphate	20% P_20_5	0
46% superphosphate	46% P_20_5	0

*Adapted from Andrews, The response of Crops and Soils to Fertilizer and Manures, 2nd Ed., 1954.