SULFUR PLACEMENT IN THE FERTILIZATION OF ALKALINE SOILS

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IN THE husbandry of alkaline soils many problems of an apparent physiological nature arise and these are usually attributed to a direct toxicity of black alkali. The term “black alkali” here refers to the OH-ions formed by the hydrolysis of sodium carbonate or sodium clay. On this basis sulfur, because of its acidic properties, has been extensively employed in the reclamation of such soils. As an alkali soil corrective sulfur is extremely effective. However, because of the amount required per acre, when it is broadcast, and the cost per ton its use has been greatly limited. Believing that sulfur deserves a definite place in the cropping of alkali soils the study of this problem has become a major project at the Arizona Agricultural Experiment Station.

Except in definitely marginal lands OH-ion concentration is not great enough to be directly toxic. This conclusion is based on the calculation of OH-ion concentrations from pH values. Obviously then the effect of pH on ion absorption and the solubility of some essential plant food elements are the major growth limiting factors rather than the effect of alkali directly on the root tissues. The elements referred to are largely calcium, phosphorus and the so-called minor elements.

As for the factors contributing to the high pH of alkaline soils, our studies are somewhat at variance with other investigators. We have supporting evidence that the alkalinity arises largely from calcium carbonate (caliche) and only in small part from sodium carbonate or sodium clay (1). Practically all the alkaline soils of the southwest are calcareous and calcium carbonate may impart a pH value of 9.5 or even higher to the soil mass (2). The latter condition is usually noted where the soil or subsoil is poorly aerated. Furthermore, calcium carbonate alkalinity has a greater influence on the insolubility of the elements mentioned above than sodium carbonate alkalinity.

Briefly summarizing, our investigations have shown that many physiological plant disturbances met in the cropping of alkaline calcareous soils are fundamentally nutritional disturbances arising from alkaline pH within a restricted root-soil contact film and are seriously hindered in this operation if the soils are alkaline and highly buffered. The problem is one of stimulating the development of an active root system or of aiding plant food absorption by maintaining the pH of the soil.

Although it is possible to do so by means of applications of organic matter, acids or sulfur, neither practical nor economical to completely remove all the active and potential alkalinity from calcareous soils, nor is this necessary.

Much success has attended the band placement of fertilizers and it was therefore postulated that the effect of alkalinity is one of reduced solubility of some essential elements it should be possible to correct this condition by placement of acidulated fertilizers. Residually acid salts produce only a limited reduction in pH, we have turned to acidulated fertilizers containing sulfur and an organic base of finely ground animal manure or sewage sludge. If simple and employed rather than mixed fertilizers the sulfur is banded with the fertilizer. By such a procedure the slow decomposition of sulfur will maintain a low pH within the immediate root zone for an extended period of time. Our experiments have demonstrated that a reduction in pH by this or similar methods increases the absorption of phosphorus, calcium, manganese and zinc (3), all of which are known to be associated with the nutritional disturbances on these soils.

The band placement of sulfur was first employed on citrus trees. These trees often develop a condition on alkaline-calcareous soils. This is variably attributed to iron, zinc, copper, or manganese deficiency. Experiments started in 1934 have shown that the chlorosis on this soil type can be corrected and a normal foliage maintained by sulfur placement (4). In this case no fertilizer was used with the sulfur because most citrus growers use only nitrogenous materials. Also in this case our interest was in the availability of minor elements rather than phosphorus or calcium.

The banding of sulfur with fertilizer is now being studied on crops which respond to mixed fertilizers.