Nutrient Cycling in Soils: Sulfur

John L. Kovar and Cynthia A. Grant

Sulfur is an essential element required for normal plant growth, a fact that has been recognized since 1860 (Alway, 1940). It is considered a secondary macronutrient, following the primary macronutrients nitrogen, phosphorus, and potassium, but is needed by plants at levels comparable to P. Sulfur deficiency will impair basic plant metabolic functions, thus reducing both crop yield and quality. Deficiencies and responses to S amendments have been reported in crops worldwide (Tisdale et al., 1986; McGrath and Zhao, 1995; Scherer, 2001), and are becoming more common (Haneklaus et al., 2008). The likelihood of a response is determined by the balance between sulfur supply and crop demand. The main reasons for recent increases in documented S deficiencies include the reduction of SO₂ emissions from various industrial sources, mainly coal-fired power plants, an increase in the use of high-analysis fertilizers with little S, decreased use of S-containing pesticides, greater S removals with ever-increasing crop yields, and continued losses through leaching and erosion of topsoil. As pointed out by Haneklaus et al. (2008), in only a few years, the reputation of S has changed from that of an undesirable pollutant to a limiting factor in crop production.

In this chapter, we provide current information on the demand for S in various cropping systems, what we know about the soil supply of S, the best ways of assessing S status and managing S inputs, and how all of this information can be put together to optimize crop production. In each section, references will provide the reader with an opportunity to explore the topic in greater detail than can be given in these few pages.

Crop Demand for Sulfur

Substantial increases in the yields of major cereal and oilseed crops during the last four decades have greatly increased crop demand for S. With world population expected to rise to 9.2 billion by 2050, crop production and consequently S supply must increase as well.

The requirement for S or any other nutrient by a crop can be defined as the total amount of nutrient in the crop (kg ha⁻¹) or the concentration (g kg⁻¹) of the nutrient in the whole plant or specific plant part that is associated with optimum growth. Data on crop S contents are useful in calculating S removals from a field and for estimating S fertilizer needs. Critical concentrations of S in plant tissue are useful in diagnosing in-season S deficiencies. Numerous references provide critical plant tissue S concentrations for various crop species (Table 7|1) (Westerman, 1990; Bennett, 1993; Mills and Jones, 1996). Both public and commercial plant analysis laboratories