Physiological Effects of Hydrogen, Aluminum, and Manganese Toxicities in Acid Soil

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I. ACID SOIL TOXICITY

Soil acidity is a major growth-limiting factor for plants in many parts of the world (McLean, 1976; Kamprath, 1978; Adams, 1978, 1981; Clark, 1982). Soils are acid because their parent materials were acid and initially low in the basic cations (Ca\textsuperscript{2+}, Mg\textsuperscript{2+}, K\textsuperscript{+}, and Na\textsuperscript{+}) or because these elements have been removed from the soil profile by normal rainfall leaching or the harvesting of crops (Kamprath & Foy, 1972). Even the normal growth of clover pasture for 50 yr decreased the pH of an Australian soil from 6.0 to 5.0 at a depth of 30 cm (Williams, 1980). Soil acidification is intensified by the use of acid-forming nitrogenous fertilizers (Pierre et al., 1971; Mason, 1980) and by acid deposition from polluted air (Ulrich et al., 1980).

Acid soil injury is an insidious problem; it may be mistaken for an ordinary nutrient deficiency, drought effect, herbicide injury, low-temperature damage, or even a plant disease. Extreme acidity in subsoils in particular is harmful because it can cause shallow rooting, drought susceptibility, and poor use of subsoil nutrients (Kauffman, 1977).

A. Components

Acid soil toxicity is not a single factor but a complex of factors that may affect the growth of different plants through different physiological and biochemical pathways, which probably are controlled by different genes (Foy et al., 1978). Furthermore, acid soils having similar pH values may cause different mineral stress problems in a given plant genotype. The specific causes of poor plant growth on acid soils may vary with soil pH, clay mineral types and amounts, organic matter contents and kinds, levels

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