CALCIUM IN THE SOIL: II. BIOLOGICAL RELATIONS

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The calcium of the soil affects plant growth directly through its important role as an essential element and indirectly through its effect on the chemical, physical, and microbiological properties of the soil. Although this fact is generally recognized and although there have been extensive investigations on the biological relations of calcium, the nature of the relationships and especially their quantitative aspects are still imperfectly understood. Thus, the problem of calcium deficiency and of calcium availability in soils has been difficult to disentangle from that of soil reaction with which it is so closely associated. Great progress, however, has been made in recent years in those phases of soil science and plant nutrition that relate to this general program. Among these may be mentioned the advances made in the subjects of soil colloids, base exchange, soil acidity, and plant nutrient absorption. Not only has this resulted in a better understanding of the relation of soil calcium to plant growth, but it has led to a greater recognition of the importance of calcium (1, 2, 32, 42, 52). In a recent review of the agronomic significance of calcium, Kelley (32) made the following significant statements: “Thus soil science has established a fundamental similarity between acid soils and certain important types of alkali soils. In both, the colloids have become impoverished in calcium. In the case of acid soils the calcium, as has been stated, has been replaced by hydrogen ions, whereas with alkali soils calcium has been replaced by sodium, but in the treatment of both, the objective should be to restore calcium to its position on the soil colloids.”

In the present discussion on the biological relations of calcium, the principal emphasis will be on a consideration of the factors affecting the availability of soil calcium to plants. Some other phases of the general subject, however, will be discussed briefly.

PHYSIOLOGICAL ROLE OF CALCIUM AND CALCIUM DEFICIENCY SYMPTOMS

Calcium has a very wide range of physiological functions in plants. One of the roles first proposed was that of neutralizing oxalic acid by the formation of relatively insoluble calcium oxalate, thus preventing the accumulation of oxalic acid to a harmful degree. It has also been suggested (54) that calcium plays a part in neutralizing other organic acids formed by the metabolic activities of plants.

Another function attributed to calcium has been as a structural component of the cell wall. Calcium pectate is one of the components of the middle lamella, and as such plays an important role in the absorption and retention of ions by the plant (70). In some recent investigations, however, Nightingale, et al. (48) have found that in the absence of calcium nitrates are not absorbed and assimilated. On the other hand, the translocation of sugars and the digestion of starch took place freely in calcium deficient plants. That calcium is necessary in nitrate reduction within the plant is shown by the fact that reductase activity is low in the absence of calcium (18), and that plants have a lower requirement for calcium when they receive urea rather than nitrate nitrogen (65). It has further been shown that calcium is an efficient agent in counteracting the detrimental effects of an unbalanced supply of other ions.