SOIL MINERALS TOXIC TO PLANTS

Soils often contain excessive amounts of certain essential

or nonessential elements, either of which at high

concentration may be injurious to the plants. Of the

essential elements, those required by plants in large

amounts, such as nitrogen and potassium, are usually

much less toxic when present in excess than are elements

required only in trace amounts, such as manganese, zinc,

and boron. Even among the latter, however, some trace

elements such as manganese and magnesium have a

much wider range of safety than others, such as boron

or zinc. Besides, not only do the elements differ in their

ranges of toxicity, but various kinds of plants also differ

in their susceptibility to the toxicity to a certain level of

a particular element. Concentrations at which nonessential

elements are toxic also vary among elements, and

plants in turn vary in their sensitivity to them. For

example, some plants are injured by very small amounts

of nickel but can tolerate considerable concentrations of

aluminum.

The injury occurring from the excess of an element

may be slight or severe and is usually the result of direct

injury by the element to the cell. However, the element

may interfere with the absorption or function of another

element and thereby lead to symptoms of a deficiency

of the element being interfered with. Thus, excessive

sodium induces a deficiency of calcium in the plant,

whereas the toxicity of copper, manganese, or zinc both

is direct on the plant and induces a deficiency of iron in

the plant.

Excessive amounts of sodium salts, especially sodium

chloride, sodium sulfate, and sodium carbonate, raise

the pH of the soil and cause what is known as alkali

injury. This injury varies in different plants and may

range from chlorosis to stunting, leaf burn, wilting, and

outright killing of seedlings and young plants. Some

plants, such as wheat and apple, are very sensitive to

alkali injury, whereas others, such as sugar beets, alfalfa,

and several grasses, are quite tolerant. In the river

valleys of Nebraska, approximately 250,000 acres of

alkaline land exist in which soybeans develop chlorosis

or yellowing (Figs. 10-13A and 10-13B), especially in

parts of such areas in which soil pH is 7.5 or higher.

However, when the soil is too acidic, the growth of some

kinds of plants is impaired and various symptoms may

appear. Plants usually grow well in a soil pH range from

pH 4.0 to 8.0, but some plants grow better at lower pH

than others, and vice versa. Thus, blueberries grow well

in acid soils, whereas alfalfa grows best in alkaline soils.

The injury caused by low pH is, in most cases, brought

about by the greater solubility of mineral salts in acid

solutions. These salts then become available in concentrations

that, as mentioned earlier, either are toxic to the

plants or interfere with the absorption of other necessary

elements and so cause symptoms of mineral

deficiency.

Boron, manganese, and copper have been implicated

most frequently in mineral toxicity diseases, although

other minerals, such as aluminum and iron, also damage

plants in acid soils. Excess boron is toxic to many vegetables

and trees. Excess manganese is known to cause a

crinkle-leaf disease in cotton and has been implicated in

the internal bark necrosis of Red Delicious apple and in

many other diseases of several crop plants. Sodium and

chlorine ions also have been shown to cause symptoms

of poor growth and decline such as those shown by

some of the trees along roads in northern areas where

heavy salting is carried out in the winter to remove ice

from roads.