Boron reactions in soils

- Boron deficiencies in crops are found mainly on low organic matter soils and on acid, sandy soils in humid regions.
- Organic matter is the storehouse for most of the available boron (B) in soils.
- Boron deficiencies frequently are associated with drought periods, because root activity decreases in the surface soil layer.
- Balanced soil fertility, which gives improved plant vigor and root growth, results in optimum uptake of B and other plant nutrients.

Reactions in soils which can affect boron's availability to plants vary significantly. The main soil factors affecting B availability are as follows:

Soil organic matter

Most of the available B in soils is found in soil organic matter. Organic matter complexes with B to remove it from soil solution when levels are high after B fertilization. Soil organic matter decomposes to resupply the soil solution to maintain adequate B levels when solution B is removed by crop uptake or leaching. Soils with low organic matter content have reduced B-supplying capacity and will usually require more frequent B fertilization at lower application rates. Soil organic matter must be decomposed to release complexed B, so conditions such as cool, wet weather or hot, dry weather which decrease organic matter breakdown will reduce available B in soils.

Soil texture

Sandy soils that are well drained are most likely to be B deficient in high rainfall situations because of their greater leaching potential. These soils may need more frequent B fertilization. However, if subsoils are fine textured (higher clay content) below sandy surface horizons, less frequent B applications may be needed. Total B is usually highest in clay soils, but plant availability may be low in these soils because of the strength by which B is held on the clay surfaces.

Soil pH and liming

Boron availability to plants decreases with increasing soil pH, especially above pH 6.5. However, strongly acid soils (pH less than 5.0) also tend to be low in available B because of B sorption to iron and aluminum oxide surfaces of soil minerals. Some crops with a high demand for B – such as alfalfa – also require a soil pH above 6.5 for optimum growth, so liming may be necessary. However, overliming acid soils often has resulted in temporary B deficiencies, especially when liming to pH levels above 7.0.

Soil microbial activity

Microorganisms break down soil organic matter, so plant-available B is released from organic complexes. Conditions favoring improved microbial activity are warm, moist soils with adequate aeration. Soil conditions which hinder optimum microbial activity are drought conditions, cold and wet soils, and poor soil tilth (poor aeration).

Soil fertility

Balanced soil fertility generally results in improved B uptake by plants. The resulting improved plant vigor and root growth allows greater uptake of B and other nutrients. This is why soil test results should be carefully examined and nutrients which are marginal or deficient should be applied at recommended rates.

Drought conditions

During periods of drought, the topsoil dries out so plant roots are unable to feed in the uppermost soil layer where most of the available B occurs. Dry weather also limits the availability of B because it restricts water flow, which transports available B in solution. Crops are more likely to become B deficient during drought periods in soils with low levels of available B.

Tillage

Boron is more available to plant roots when the surface soil is tilled. Tillage allows soil mixing and improves aeration and drainage. These conditions are optimum for organic matter breakdown, which releases available B. As crop production systems shift to reduced tillage or no-till management, organic matter will accumulate on or near the soil surface and may not break down rapidly. Boron availability then will become more dependent on surface moisture conditions, and fertilizer management may become more crucial.

Summary

Boron deficiencies are found mainly on soils which are low in organic matter, and also on acid, sandy soils especially in humid regions where leaching can occur. An understanding of B reactions in soil will assist in predicting where B deficiencies are most likely to occur. Results of soil tests for available B will give the B status of soils in a particular field. Recommended B rates should be applied if available B levels are low or marginal, especially for crops with a high-B requirement, such as alfalfa.