Effective Boron Management

Though used in micro amounts, this vital nutrient plays a crucial role in a plant's health and development.

Like zinc, discussed in an earlier issue, boron is one of seven plant food elements required in micro amounts but producing a macro impact on plant development. Seven decades have passed since scientists first demonstrated that boron is essential for plant growth.

Although many functions of boron in plant growth are not fully understood, a great deal is known. Some of the functions in plant nutrition this unique micronutrient is involved in are:

- cell wall structure
- sugar transport
- cell division
- plant hormone regulation
- flowering and fruiting.

Availability

Crops need boron throughout their life cycles. Soils, for one reason or another, may not be able to supply boron in quantities to meet those needs. Boron availability is dependent on several factors and conditions existing in the soil-plant system, and is strongly influenced by rainfall—or lack of it—during the growing season. Some of the factors that influence boron availability are:

Soil organic matter. This is the primary source of "reserve" boron. Organic matter complexes with boron to remove it from the soil solution when levels are high after fertilization. It then resupplies the soil solution to maintain adequate levels when boron is removed by crops or leaching. Soils with low organic matter will usually need more frequent boron fertilization at lower amounts per acre.

Soil texture. Sandy soils that are well drained are most likely to be boron deficient because of leaching. If subsoils are fine-textured, less frequent additions of boron fertilization may be needed. Total boron is usually highest in clay soils with high organic matter. However, plant-available boron may be quite low because of the strength by which boron is held on clay surfaces.

Cultivation. Boron is made more uniformly available to plant roots when mixed throughout the upper soil profile by plowing. Plowing also speeds up the rate of organic matter breakdown, releasing boron into the soil. As crop production systems shift to reduced tillage and no-till management, organic matter will accumulate on and near the soil surface. As this happens, boron availability will become more dependent on surface moisture and rainfall patterns. Fertilizer management will become more critical.

Drought. During periods of drought, topsoil dries out. Crops are unable to feed in the uppermost part of the soil, thus are subject to temporary boron deficiency. Since boron moves by mass flow of soil water, dry weather limits availability by restricting flow of water.

Microbial activity. Microorganisms break down soil organic matter, which allows the release of boron from organic complexes. Microbial activity is lowest under drought conditions, or in cold, wet soils. It is highest when soils are moist and warm. Where microbial activity is highest, boron release is highest.

Soil pH and liming. Boron availabili-ty decreases with increasing pH. A drop in plant uptake is often dramatic at soil pH levels above the 6.3 to 6.5 range. On the other hand, crops such as alfalfa, which have a high boron demand, also require a soil pH above 6.5 for optimum growth. Liming acid soils sometimes induces a temporary boron deficiency.

Soil Fertility. Availability and use of soil boron depend on fertility levels. Balance among the various soil nutrients, as well as actual boron level, influence its plant-use efficiency. There are particularly strong boron interrelationships with nitrogen, potassium, and calcium. For example, work by Woodruff in South Carolina on corn has shown that boron fertilization prevented yield reduc-tion where high K fertilization was used.

Yield determines need

Crop production will fall short of genetic potential when any of the essen-tial elements is in short supply. This is as true for boron as it is an element like nitrogen. The difference is a shortfall of nitrogen is often more visible.

Total requirement by plants for a specific nutrient can be highly variable. Reasons are sometimes climate-driven, but more often they are management

Table 1. Boron removal by alfalfa increases with yield.

Yield	Nutrient Removal		Location
ton/A	lbs/A	tons/A	
6.0	0.09	0.015	Average [1]
8.0	0.43	0.053	New Jersey
8.5	0.44	0.052	Pennsylvania
9.0	0.63	0.070	Michigan
10.8	0.54	0.050	Kansas

[1] Average removal for several locations.

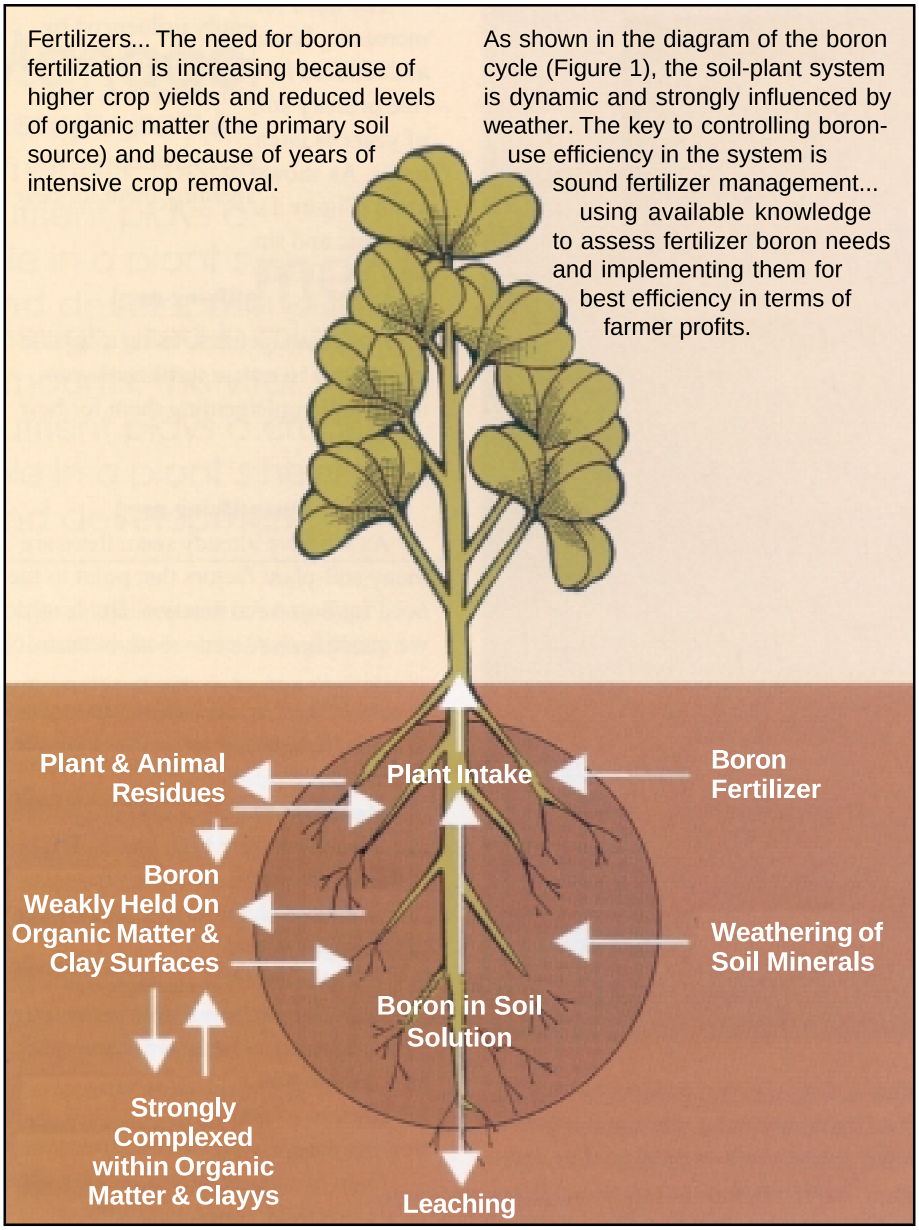

Figure 1. The boron cycle...a dynamic system, changing daily as it is influenced by the soil-plant system, wether and fertilizer management.

Table 2. Relative requirements of boron.

High	Medium	Low
Cotton	Corn	Barley
Canola	Flax	Oats
Sunflower	Grain Sorghum	Soybeans
Cauliflower	Brussel Sprouts	Rye
Beets	Cabbage	Rice
Sugar Beets	Onions	Wheat
Carrots	Potaoes	Beans
Broccoli	Sweet Corn	Peas
Apples	Tomatoes	Pecan
Peanuts	Tobacco	Sugarcane

related. Total boron need can be traced to differences among crops and produc-tion practices such as yield goal or variety selection needed for improving productivity and profitability. For example, total boron removed in Table 1 is six times higher for alfalfa yielding 10.8 tons/A than that yielding 6 tons/A. By comparison, boron content of high-yielding corn is about the same as that for alfalfa yielding 6 tons/A.

The need for boron fertilization is increasing because of higher crop yields and reduced levels of organic matter (the primary soil source), and because of years of intensive boron removal by crops. As shown in the boron cycle dia-gram (Figure 1), the soil-plant system is dynamic and strongly influenced by weather. The key to controlling boron-use efficiency in this system is sound fertilizer management, using available knowledge to assess fertilizer boron needs and implementing them for best efficiency.

Quantifying need

As we have already seen, there are many soil-plant factors that point to the need for boron fertilization. But how do we quantify that need—both in terms of documenting the fact that fertilizer should be applied and the rate per acre to use? There are several places we can look for help.

Management capability. Well-managed farms produce high yields. High yields require greater levels of production inputs (including boron) for sustainability. Depending on soil fertility levels and crops being grown, a part of the crop's boron requirement may need to be provided as fertilizer. Remember, as a farmer moves his yield goals up, his chances of needing boron fertilization increase.

Field history. Once boron deficiency exists in a field, those soils will always—to varying degrees—be deficient. The highest boron-demanding crop grown in the rotation should be fertilized with boron.

Crop needs. Table 2 shows which crops have high, medium, and low boron requirements. Keep in mind that some varieties and hybrids within a species will have higher than normal requirements, particularly those with high yield potential grown at high populations per acre.

Plant analysis. This diagnostic tool can help predict boron needs when soil tests and deficiency symptoms are not conclusive. Scientists have determined plant tissue levels of boron that are optimum for most profitable production. The ideal system is to provide boron to keep crop tissue levels in the sufficiency range. Both “deficient” and “excess” concentrations should be avoided. Some crops are quite sensitive to excess boron, so care should be taken to avoid over-fertilizing. On the other hand, too little boron can result in low yield and poor quality production.

Soil testing. A boron soil test is one of several important factors used to assess fertilization need. The soil test value receives much weight, but interpretation of boron testing is subject to soil, crop, and water management factors. Consult your local agricultural soil testing experts for interpretation.

Geographic area. As with most other essential nutrients, boron requirements vary by geographic area. Factors such as crop, soil, temperature, and precipitation influence relative need.

All of the above should be used in determining boron needs. They help take the guesswork out of formulating a sound boron fertilizer program for profitable crop production.

Soybeans respond

Studies conducted by Dr. Gary Gascho of the University of Georgia have shown the benefits of using boron on soybeans. They have also shown the effects soil variation can have. Positive yield response to applied boron was greater on deep sandy soils than on sandy loam underlain by a semi-permeable layer.

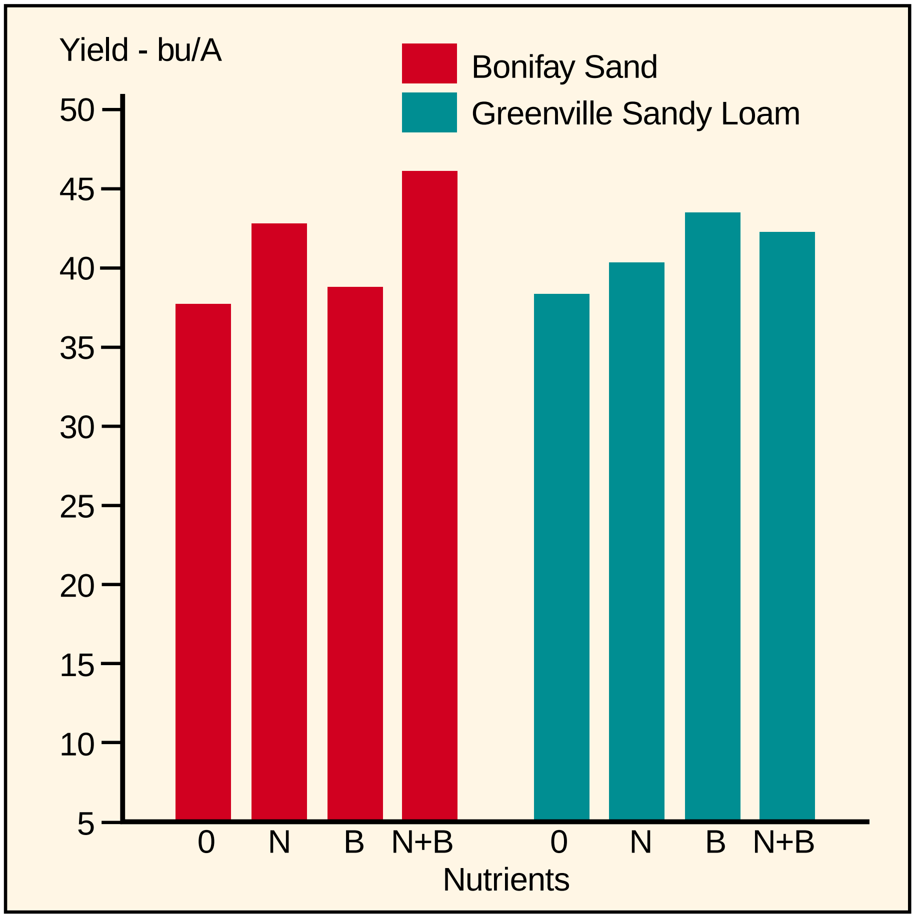

Figure 2. Soybean yield response to spray treatments made during pod development (R4) at two sites, Gascho, University of Georgia, 1992.

Results in 1992, for example, showed significant yield responses on a Bonifay sand to N, and N plus B (Figure 2). Responses on the Greenville sandy loam were positive, but not statistically significant.

Yield responses of greater than 5 bu/A have generally been limited to irrigated, deep sandy soils. These soils have little anion exchange capacity, and N is leached rapidly. Therefore, it is not surprising that deficiencies of N and B are often found on such soils and that supplemental fertilization can result in yield increases.

Sound agronomics

An agronomically sound and environmentally safe boron fertilization program is one that is scientifically based and yet responsive to crop, climate, and farm management differences. Such a program provides crop boron needs in an efficient manner and considers not only the rate of boron needed but also the source, timing, and method of application.

Scientifically based crop production systems are essential for providing a growing population with an abundance and variety of safe, reasonably priced, high-quality food and fiber.