AGRONOMY NOTE

Boron applications for increased soybean yields

Overview

- Soybeans require an adequate supply of available boron, especially during flowering and seed development. Multiple foliar sprays of *Solubor*® will ensure an adequate supply of boron during this stage of growth.
- Foliar sprays of *Solubor* can be combined with other field treatments, such as insecticides, to reduce costs.
- Preplant soil application of *Granubor*® plus foliar sprays of *Solubor* during the season are recommended for soils testing low in available boron (B).

Soybeans require a high fertility soil for optimum production. Well-drained soils with a good supply of organic matter which have been well fertilized and limed over several years will generally produce the highest soybean yields.

Cell wall strength, cell division, fruit and seed development, and sugar transport are plant functions related to boron. While boron requirements for optimum plant nutrition are low compared with those of the primary nutrients, the need for boron is especially significant in flowering and seed development.

Deficiency symptoms

Because boron is vital to flower formation and seed production, a decrease in boron supply during this critical stage can result in decreased yields.

As with many other crops, the first signs of boron deficiency occur in the roots. Root tips die and when new roots initiate it causes a rosette appearance.

Boron deficiency can also cause:

- Death of the shoot growing point and subsequent proliferation of lateral shoots with brittle petioles[4]
- Stunted growth and fewer nodes per plant
- Fewer seeds per pod
- Less weight per plant
- Interveinal chlorosis of foliage with brittle leaves in the youngest growth
- Floral buds to wither before opening

Soybean seed produced by boron deficient plants and planted back into boron deficient conditions can suffer significant yield losses. Soybeans produced by boron deficient plants but planted into adequate boron conditions produce well.

Boron deficiency in soybeans has been shown to delay soybean maturity by as much as two weeks thus exposing the crops to the risks of bad weather or shattering. “Timeliness of harvest is an important consideration and possible benefit of boron fertilization, which should be considered when growers decide whether to include boron as a part of their fertilization regime.”[1]

Soil tests and plant analysis

Boron deficiencies may be suspected in coarse-textured soils where organic matter content is low, on soils with a pH above 6.0, and on recently limed soils. Soil testing and plant analyses are both helpful in assessing the potential boron supplying capacity of the soil and the current boron status of the growing plant.

The critical level of hot-water-soluble boron for soybeans in most soils ranges from 0.2-0.5 ppm, depending on the soil pH, organic matter content, and texture. Soybeans which are grown on soils that are less than the critical level generally will respond to applied boron.

The critical level of boron in the top mature soybean leaves is about 20 ppm, but the ideal level is about 30 ppm.

Various sources list the following ranges of tissue values for boron in soybeans:

- Deficient: 9-10 or less than 10 ppm B
- Low: 10-20 or less than 20 ppm
- Sufficient: 20-60 ppm
- Normal: 20-80 or 21-55 ppm
- High: 50-100, greater than 80, 63, or 50.1-80 ppm
- Excess: 63, greater than 80 or 100 ppm

Research

Although soybeans are listed as tolerant to boron deficiency, field studies have shown that boron fertilization can increase yield from 2-17.91 bushels per acre when soil is boron deficienct[2].

Under boron deficient conditions, soybean seed will have greatly reduced boron concentrations. Soybean seed produced in low boron conditions in commercial fields in Arkansas in 20031 contained as little as 1.9 mg B/kg seed while boron concentrations in fields without boron deficiency produced seed containing from 26-27 mg B/kg[3].

In this same study, deficiency symptoms were not observed until soybean plants neared maturity[1]. The delayed maturity of boron deficient soybeans would be difficult to notice without boron sufficient soybeans in the field with which to compare.

Application of 1.0 lb B/acre, averaged across application times, increased soybean yields from 8.2 to 118% (3.9-17.4 bu/acre) above the unfertilized control.

Boron application timing

Research has shown that applications at the V2 stage at rates greater than or equal to 0.5 lb/acre produced the best results.

Data below shows increased soybean yields with foliar applications of boron, nitrogen (N), and/or magnesium (Mg) which were made during the R3 to R5 stages of growth in Georgia. Four foliar applications of various combinations of *Solubor*, urea, or UAN solution; and $MgSO_4$ resulted in 5-20% increases in yields. Highest yield increases were with B+N or B+Mg foliar sprays applied at 25 gal/acre. Other studies have reported soybean yield increases with one or two foliar sprays of 1.25 lbs of *Solubor*/acre applied alone or in combination with the insecticide, Dimilin®.

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Response of soybeans to late-season foliar sprays of one or more nutrients

Nutrient applied, lbs/acre			Yield, bu/acre	
B	**N**	**Mg**	**Bonifay sand**	**Greenville sandy loam**
—	—	—	37.8	38.3
—	40	—	44.3	40.7
0.4	—	—	38.9	43.6
0.4	40	—	46.0	42.2
—	—	0.25	40.2	40.9
—	40	0.25	39.4	43.5
0.4	40	0.25	47.2	41.3
0.4	40	0.25	42.0	42.5

Preplant granular applications of 1 lb B/acre are effective in preventing boron deficiency.

If foliar fertilization is preferred, soybean plants with leaf boron contents below the critical level should be sprayed one or more times with *Solubor* after flower initiation and during seed development. Growers should apply 0.5 lb B/acre at least once. A second application of 0.25 or 0.50 lb B/acre may provide additional yield benefits at a minimal cost in fields where severe boron deficiency is observed.

Soybean fertilizer recommendations

Yield responses to applied boron may be inconsistent and seasonal, probably due to environmental effects on soybean growth. However, both yield and quality of soybeans may be improved with boron fertilization because available boron levels are low in some soils.

In addition, yield response may diminish as the duration of boron deficiency is prolonged[1]. Boron deficiency in Arkansas was noted in alkaline silt loam soils in certain regions of the state. Other regions of the state with similar soils showed no boron deficiency.

At two of the Arkansas trial sites, grain moisture measurements were greatest in the untreated checks and were indicative of the magnitude of the maturity differences observed. Soybean growth and yield were generally maximized when boron was applied at rates from 0.5-1.0 lb B/acre.

Boron should be applied for soybeans especially on sandy soils in high rainfall regions or with over-irrigation because soluble boron can be easily leached from the root zone. Soybean response to applied boron generally is greatest when there are adequate supplies of the other nutrients.

Boron recommendations for soybeans	
Marginal soil test boron and/or leaf analyses, or dry weather during critical stages	Low soil test boron and a prior history of boron response
SOLUBOR®	GRANUBOR®
Multiple foliar sprays at rates of 0.5 lbs (0.1 lbs B/acre) weekly for 3-5 times before flower initiation and development. *Solubor* can be applied to vines alone or with insecticides.	A soil application of 7 lbs of *Granubor*/acre (1 lb B/acre) surface broadcast and incorporated prior to planting. If boron is banded with fertilizer at planting, 0.5 lbs B/acre is suggested.

References

1. Slaton N. 2003. Soybean Response to Boron Fertilizer Application Time and Rate in Arkansas. AR-23F.
2. Gupta UC. 1993. Boron and Its Role in Crop Production. Boca Raton: CRC Press.
3. Bundy LG and Oplinger ES. 1984. Narrow row spacings increase soybean yields and nutrient removal. Better Crops Plant Food. 68: 16-17.
4. Shorrock VM. 1983. Boron Deficiency–Its Prevention and Cure. London: Borax Holdings.
5. Jones JB. Interpretation of plant analysis for several crops. p49-50.
6. Gupta UC. 1993. Chapter 8: Deficiency, Sufficiency and Toxicity Levels of Boron in Crops. Boron and Its Role in Crop Production. Boca Raton: CRC Press.
7. Clemson University Lab web site.
8. Wisconsin A2522 Soil and Applied Boron.

About U.S. Borax

U.S. Borax, part of Rio Tinto, is a global leader in the supply and science of borates—naturally-occurring minerals containing boron and other elements. We are 1,000 people serving 650 customers with more than 1,800 delivery locations globally. We supply around 30% of the world's need for refined borates from our worldclass mine in Boron, California, about 100 miles northeast of Los Angeles.

Our local agriculture experts understand the uses and benefits of boron on crops. In addition to a global sales team, we have a number of agronomists on staff to help fertilizer distributors maximize the benefits of borates in agriculture applications. Our ag team can answer individual growers' questions and concerns about their particular crop.

High quality, high reliability, high performance borate products. It's what we're known for.

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