Effects of Boron on Seedling Establishment of Annual Legumes

By G.R. Smith, V.A. Haby, C.L. Gilbert and I.J. Pemberton

Texas research shows that supplemental boron (B) on deficient soils significantly increases legume root development and improves seedling establishment probabilities.

WINTER-ANNUAL CLOVERS are often overseeded on warm-season perennial grass sods for grazing in east Texas. Establishment, at initial planting or increasing stand by natural reseeding, is a major management problem when using these legumes. Soils in the east Texas timberlands are usually sandy and acidic with low native fertility.

Phosphorus (P) and potassium (K) fertilization and liming are generally necessary for annual clover forage production. Boron fertilization has been recommended, but has not been widely used in forage fertilization programs. Field experiments have shown improved reseeding of annual clover stands when B deficiencies were corrected.

Greenhouse Studies

In the greenhouse, B was mixed with soil in individual pots at the rate of 0, 1.5 or 3.0 lb B/A with Mt. Barker subterranean clover seed. Plants were harvested at 2, 3 or 4 weeks. Boron fertilizer significantly increased root, and to a lesser degree, shoot dry weights of seedlings when compared to unfertilized plants. These positive effects on growth were evident when plants were three weeks old (see photo next page).

At four weeks, root dry weights of plants fertilized with 1.5 or 3.0 lb B/A were nearly twice that of unfertilized controls. Shoot dry weights at four weeks were 14 and 20 percent greater for plants fertilized with 1.5 or 3.0 lb B/A, respectively, than plants which received no B (**Figure 1**).

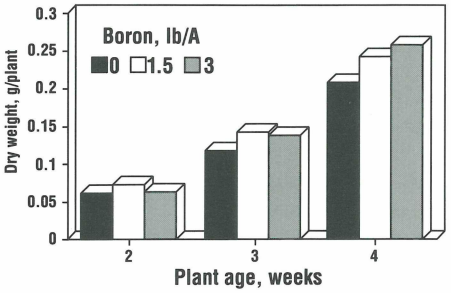

Figure 1. Average shoot dry weight at 2,3 and 4 weeks of growth as affected by boron rates.

The increased root mass was due to increases in taproot length and number and size of lateral roots. Taproot lengths were already significantly longer at two weeks for B fertilized plants. After four weeks, this difference was amplified (**Figure 2**). Taproots of unfertilized plants grew an average of only 0.4 inches in two weeks, while those of plants receiving 1.5 or 3.0 lb B/A grew 2.6 and 2.7 inches, respectively. The total number of lateral roots was greater in treatments receiving B than in no B controls. A similar effect was observed for the number of lateral roots over 0.4 inches. In most cases, the 3.0 lb B/A rate caused a slight, but insignificant, growth depression of the subclover seedlings.

Plants which had not received B exhibited typical B deficiency symptoms: stunting of growth at the apical meristem and wrinkled, thicker, bluish-green leaves. Most seedlings had not progressed beyond the cotyledonary stage. Stunted root growth was evident as well.

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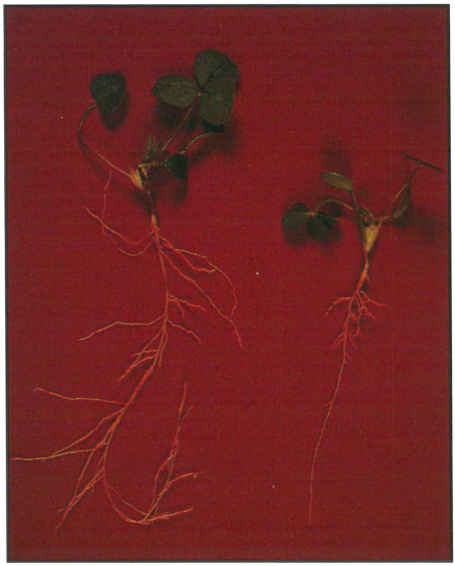

RESPONSE of subterranean clover to B is illustrated with these seedlings, 3 weeks after planting. Plant at left received 1.5 lb/A, while plant at right received no B.

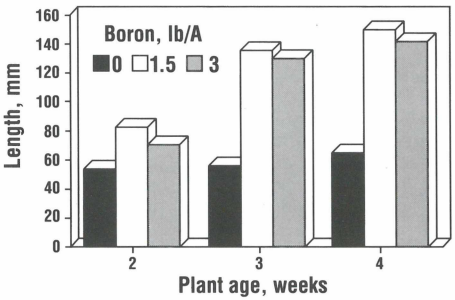

Figure 2. Taproot length at 2, 3 and 4 weeks as affected by B rates.

In a second experiment, B was mixed with the soil on a soil weight basis at the rate of 0, 1.0, 2.0 and 3.0 lb B/A. Legume varieties used included Dixie crimson, Yuchi arrowleaf, common ball, Bigbee berseem, H-18 rose, Mt. Barker subterranean clovers and hairy vetch. Measurements taken after four weeks were root length, shoot and root dry matter yield, total number of lateral roots, number of lateral roots over 0.4 inches, and number of lateral roots over 1.2 inches.

Boron fertilizer, whether applied at 1.0, 2.0 or 3.0 lb/A, significantly increased some aspect of root growth compared to unfertilized controls for all clover species tested. Hairy vetch did not exhibit enhanced root growth. All clovers possessed longer roots and more lateral roots longer than 1.2 inches when fertilized with B. Except for subterranean and rose clovers, all clovers fertilized with B had a greater number of total lateral roots.

Field Studies

In a third experiment, B was applied at 1 and 2 lb/A on three different field sites. Soil samples were taken 15 days before and after B application and at monthly intervals for five months. Sample depths include 0-6, 6-12, 12-24, and 24-36 inches. Preliminary analysis of these data indicates that a 2 lb/A B rate under field conditions provides marginal correction of a B deficiency on sandy soils. Two lb B/A increased soil B from 0.25 parts per million (ppm) to 0.41 ppm at the 0-6 inch sample depth and from 0.1 ppm to 0.36 ppm at the 6-12 inch sample depth.

Application

Our studies show that B is crucial for annual clover seedling establishment, growth and survival. Boron at 1.5 lb/A under greenhouse conditions resulted in dramatically larger plants when water supply was adequate. Plants fertilized with B were also more drought tolerant than unfertilized plants. The deficient native soil B level of less than 0.3 ppm available B was corrected to 0.8-1.0 ppm B by addition of 1.5 lb B/A in the greenhouse studies. Under field conditions, more than 2 lb B/A may be required to correct soil B deficiency on sandy soils.

More research is needed to determine the best method to deliver the required B to the clover seedlings. Annual clover forage production depends on successful seedling establishment. Correcting soil B deficiency before planting will help ensure greater seedling survival under drought conditions and improve early seedling growth and establishment. ■