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EFFECT OF SOIL AND FOLIAR-APPLIED BORON ON THE PHYSIOLOGY AND YIELD OF COTTON

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Abstract

Boron (B) has long been known as an essential micronutrient element required for optimal growth and development of cotton (*Gossypium hirsutum L.*) plants. Boron is important for pollen germination and pollen tube growth necessary for successful fruit formation. Therefore, B deficiency during flowering and fruiting may significantly reduce boll retention resulting in low yield and fiber quality. Current production recommendations in Arkansas call for initial pre-plant soil applications of 1.0 lb to 2.0 lb B/acre or two to six foliar applications of 0.1 to 0.2 lb B/acre. This recommendation is based largely on research conducted nearly 30 years ago with no recent work to substantiate B recommendations pertaining to modern cultivars and production practices. Also, little is known about the effect of B deficiency during early growth of cotton (prior to squaring) on subsequent growth and carbon metabolism in the plant. To better understand both the agronomic and physiological effect that B has on the cotton plant, a series of field trials and one growth chamber study were conducted.

Field studies were conducted at six separate locations across Arkansas from 1999 to 2001 to determine the effect of B on yield and quality of cotton. Irrigation, B application rate, date of planting and cultivar used varied with the location tested. All studies were arranged in either a randomized complete block or a split-plot design depending on the setup of the treatments. The growth chamber study was conducted in Fayetteville, AR in 2000 to determine what effect gradual B removal had on the physiology of the cotton plant. In this study, all plants were watered with half-strength Hoagland's nutrient solution during the first two weeks after planting to maintain a sufficient nutrient and water supply. At two weeks after planting, plants of similar size were selected and divided into two treatments. The two treatments included plants receiving nutrient solution with B (+B) and without B (-B). The –B pots were initially flushed with deionized water to remove any B in the pots prior to treatment initiation. At the onset of B removal, weekly measurements were taken to determine the effect of B fertility on net photosynthesis, stomatal conductance, transpiration, plant growth, dry matter accumulation and nonstructural carbohydrates of leaves and fifteen day old floral buds.

Results from the field trials showed no clear trend for increasing lint yield or fiber quality following soil or foliar B fertilization, and addition of B was only able to significantly increase lint yields in one out of 10 field trials. Boll number per meter and average boll weight were also not significantly affected by B fertilization, which helps to explain why yields were not increased at the test locations in Arkansas. The probable reason that the agronomic side of this Boron fertilization study failed to show significant improvements in boll parameters, lint yield and quality is that the majority of soils in Arkansas currently have appropriate levels for proper growth and development of cotton. Results from the growth chamber, however, indicated that B is extremely important in maintaining physiological processes of the plant. Physiological processes including net leaf photosynthesis, stomatal conductance and transpiration were all significantly decreased by 4 and 5 weeks after B removal. Height, main-stem nodes, square number and dry matter of leaves, stems, roots and squares were all significantly decreased once B had been removed for 4 weeks. Boron deficiency also reduced assimilate translocation resulting in a significant increase in leaf starch and a significant decrease in floral bud nonstructural carbohydrates. It was also determined that the critical level of B for the fourth main-stem leaf from the terminal (used for petiole analysis) was 17 mg kg^{-1}; below which plant growth and physiological processes were adversely affected.