

Foliar Boron Application Enhances Almond Yields

By Patrick Brown, Hening Hu, Agnes Nyomora and Mark Freeman

Boron deficiency occurs widely in the fruit-growing regions of California and is more common in the lighter textured soils supplied with high quality irrigation water. Severe B deficiency, however, resulting in characteristic leaf symptoms, is relatively uncommon and can be effectively controlled with soil application of B fertilizers.

There is mounting evidence in the fruit growing regions of California, Oregon and Washington (pistachio, almond, apple, pear) that alleviation of foliar symptoms of B deficiency may not be sufficient to bring the plant to full yield. Indeed, there are many examples in which yield has been increased by foliar B application to plants with no visual signs of B deficiency. This observation and the well documented role of B in pollen growth and fertilization suggest that flowering and fruit set may have a higher demand for B than does leaf growth. This phenomenon was investigated over a three-year period in a commercial almond orchard in Fresno County, CA.

Extensive experimentation with many different crop species demonstrates that both soil and foliar applications of B can effectively increase tissue B levels above the critical value of 30 to 60 parts per million (ppm) for vegetative growth of almond. Sodium borate (Solubor) and

boric acid formulations are both rapidly absorbed by almond when leaves are present and will effectively increase leaf B concentrations. However, since B is required for effective nut set it is also necessary to ensure that flower buds have

adequate B supplies to carry them through flowering, fertilization and nut set. Given the highly variable nature of soil B uptake that results from changes in water availability, temperature and organic matter content, it is suggested that a supplemental foliar B application may be beneficial. In comparison with the

high value of crops such as almond, the cost of foliar B is low. Since the number of nuts set is critical to productivity, foliar application of B is worthwhile whenever B levels are moderate or low.

California Almond Studies

Trials were conducted in a low B region of Fresno County. Though almond trees in this area did not show distinctive B deficiency symptoms in vegetative parts, B concentration measured in July leaf samples were <30 ppm and nut production was very low. The following symptoms were observed: trees flowered early and were very prolific, but within two weeks of flowering large numbers of flowers and small nuts had fallen from the tree; after an additional two weeks, essentially all nuts had been aborted with less

A three-year study in California shows that foliar boron (B) applications can increase yield in almonds even where there are no visible leaf symptoms of B deficiency. Data suggest that foliar applications act specifically to enhance the number of flowers that set fruit.



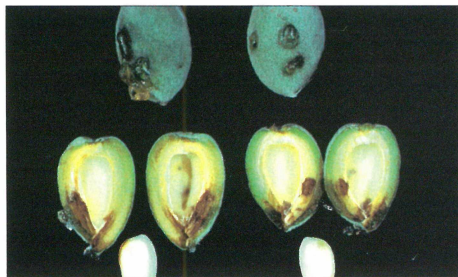
ALMONDS on the bottom row demonstrate a boron deficiency.

than 5 percent of the initial flowers resulting in a viable nut. In many cases these trees then became excessively vigorous as a result of the lack of carbon demand from the developing fruit. At maturity, nuts on some varieties had excessive production of gum and were unsuitable for consumption. Yield was less than 20 percent of the county average for trees of this age in similar climatic conditions. Reports of similar symptoms in pear and pistachio suggested this may be the result of a marginal deficiency of B. Based on the success of our work in pistachio, a series of experiments was established to develop an effective B foliar spray program for almond.

Foliar Boron Application

Foliar B sprays were applied at 0, 1, 2, and 5 lb/A sodium borate (20.5 percent B) in 100 gallons of water to a 15-year old almond orchard. Applications were made at three different times over a one-year period. Treatments were applied to 15 replicate trees. Number of flowers, percent flowers setting fruit, leaf, bud and flower B concentrations, as well as total yield were determined. The experiment was repeated for three consecutive years. The results of the 1994 season presented here are representative of the entire experiment.

Applications of foliar B two weeks after nut harvest (September 1993) resulted in a significant increase in bud B con-



EXCESSIVE production of gum produces unsuitable almonds.

centration sampled the following spring (**Figure 1**). Boron concentrations increased from 20 to 90 ppm as B increased from 0 to 5 lb sodium borate/100 gallons. Leaf B concentrations sampled during the summer (**Figure 2**) also increased in direct proportion to B application.

Increased concentrations of B in flower buds (**Figure 1**), flowers and pollen (data not shown) resulted in a significant increase in the viability of almond pollen from 55 percent to >75 percent (**Figure 3**).

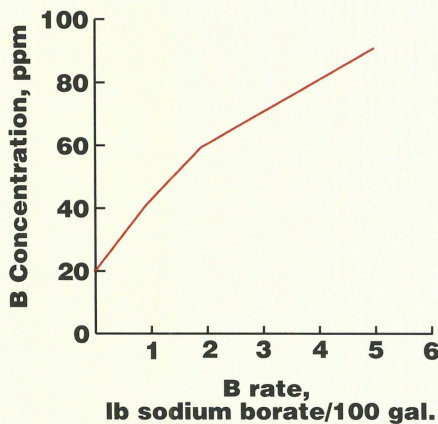


FIGURE 1. Effect of foliar B application on concentration in bud (February sample). Foliar B applied the previous September.

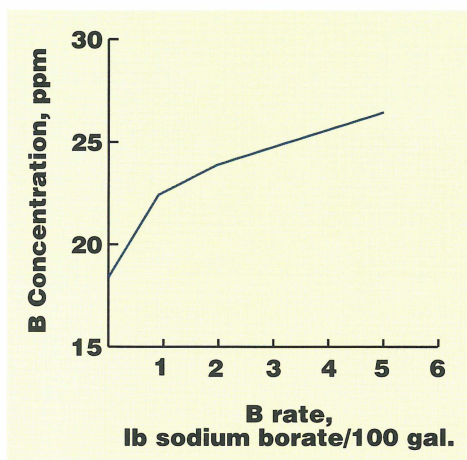


FIGURE 2. Effect of foliar B application on concentration in leaves (July sample). Foliar B applied the previous September.

Foliar B sprays also dramatically improved nut set, which is the primary determinant of yield (**Figure 4**) and profitability. Nut set increased from 45 percent to 75 percent with the application of 1 or 2 lb sodium borate/100 gal., but decreased to 55 percent when higher B

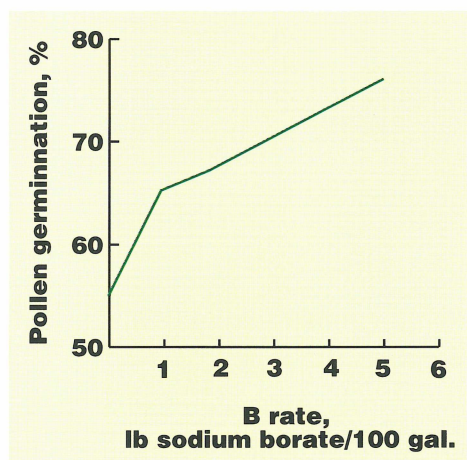


FIGURE 3. Effect of foliar B on pollen germination rate in almond. Foliar B applied the previous September.

rates were used. It is likely that the increase in nut set in response to B application was the result of the observed increase in pollen viability.

To determine the optimum time for B applications, trials were performed applying 1 and 2 lb sodium borate/100 gal. in September 1993, December 1993, or February 1994, to almond. Yields were collected in August 1994. Boron application in September 1993 (**Figure 5**) enhanced fruit yield by 67 percent. No other application date significantly affected yield in this or any other year. The need for B in flower buds may require that it be applied during bud formation, which occurs in late summer in almond. Foliar B application appears to be the most effective way to supply B at this critical stage of development.

Summary

The results of this and similar research with pistachio suggest that foliar B application can increase yield in nut crops even in the absence of any visible (i.e. vegetative) signs of B deficiency. The

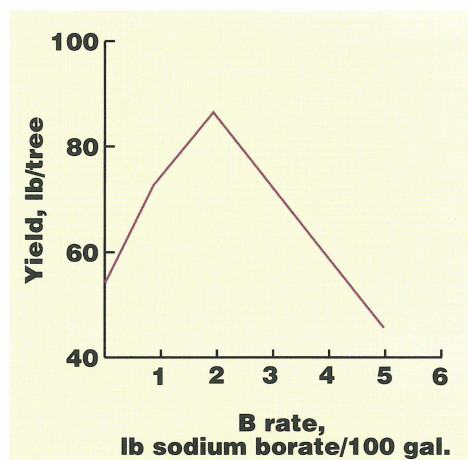


FIGURE 4. Effect of foliar B on almond yield. Foliar B applied the previous September.

application rates utilized in these foliar trials are low in comparison to normal soil application rates and when provided in even slight excess can reduce yields. In both pistachio and almond there is a specific brief period at which foliar B sprays are effective. These observations suggest that foliar B applications act specifically to enhance the number of flowers that set fruit. Soil applications that enhance whole tree B levels may not have this same specific effect.

Soil applications of B effectively correct chronic B deficiency and should be used in programs where soil and water B levels are low. A combination of soil application plus foliar B application is recommended when leaf B levels are

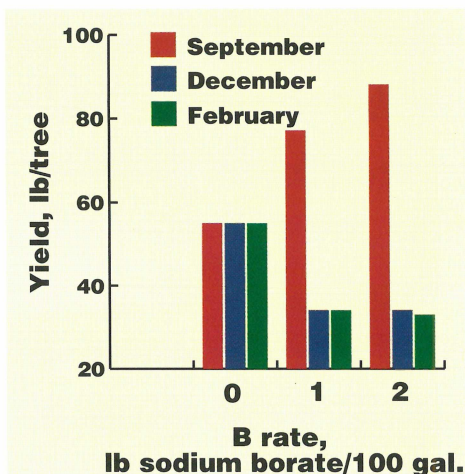
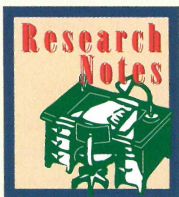


FIGURE 5. Effect of foliar B application on yield at three times of application.

in excess of 200 ppm suggests B toxicity. Under these conditions no application of B is warranted. BC

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Florida: Bahiagrass Response to Dolomitic Limestone

Bahiagrass is an important forage crop in the southeastern U.S. A four-year field study on a Pomona fine sand in Florida demonstrated the importance of dolomitic lime for bahiagrass production on low pH soils.

Four rates of dolomitic lime (0,1,2, and 3 tons/A) were compared in 1989 through 1992. Dolomitic lime increased soil pH and reduced exchangeable aluminum (Al). It also increased yields,

which ranged from 3.1 to 3.3 tons/A in 1989, 3.4 to 3.9 tons/A in 1990, 3.7 to 4.9 tons/A in 1991 and 3.4 to 4.3 tons/A in 1992. Data indicate that part of the yield response is due to addition of magnesium (Mg) from the dolomite. Year to year variation in yields was also affected by rainfall differences. BC

Source: J.E. Rechcigl, P. Mislevy and H. Ibricki. Journal of Production Agriculture, 8:249-253 (1995).