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Apple Orchards Respond To Boron Fertigation

Canadian studies show increase in leaf and fruit boron concentrations.

Summary: Leaf concentrations of boron (B) were effectively increased via foliar application. Foliar B applications ameliorated deficiency systems associated with 'blossom blast' in the spring and fruit corking and cracking at harvest. Fertigated B was mobile within the soil and it was relatively easy to increase leaf and fruit B concentrations via fertigation of modest rates of 0.34 g per tree. The ready response of tissue B concentrations to fertigated B suggests caution is required to select moderate B application rates in order to avoid toxicity when fertigating B. There were minor differences in leaf B concentrations among 'Gala,' 'Fuji,' 'Fiesta,' and 'Spartan' apple cultivars during the field trails. Nevertheless, in general, all cultivars responded similarly to B treatments, including non-application or application via foliar spray or fertigation.

An experimental high-density apple block (674 trees/A) on M.9 rootstock was planted in 1992 and maintained until 1996 as a randomized, replicated split-plot experiment with five nitrogen (N) potassium (K) fertigation treatments, each with subplots containing four apple cultivars ('Gala,' 'Fuji,' 'Fiesta,' and 'Spartan'). Management of B nutrition varied throughout the experiment, ranging from no application (1992-93) to foliar applications (1994) to fertigation of 0.34 g B per tree during the growing season (1995-96). Deficient concentrations of B were measured in leaves, and 'blossom-blast' B deficiency symptoms were observed within two years when applications of B were absent. Foliar application of B increased leaf B concentrations and ameliorated B deficiency symptoms. Boron fertigation readily increased root zone soil solution B concentrations and increased leaf B concentrations to values within the sufficient optimum range for apples. Generally, cultivars responded similarly to B treatments although, relative to other cultivars, 'Spartan' and 'Fuji' had higher concentrations of B in leaves

In the fruit-growing region of the Pacific Northwest of North America, fertigation induced problems on sandy soils have included rapid soil acidification leading to nutrient imbalances such as K deficiency. This has stimulated the development of adaptive strategies to minimize soil

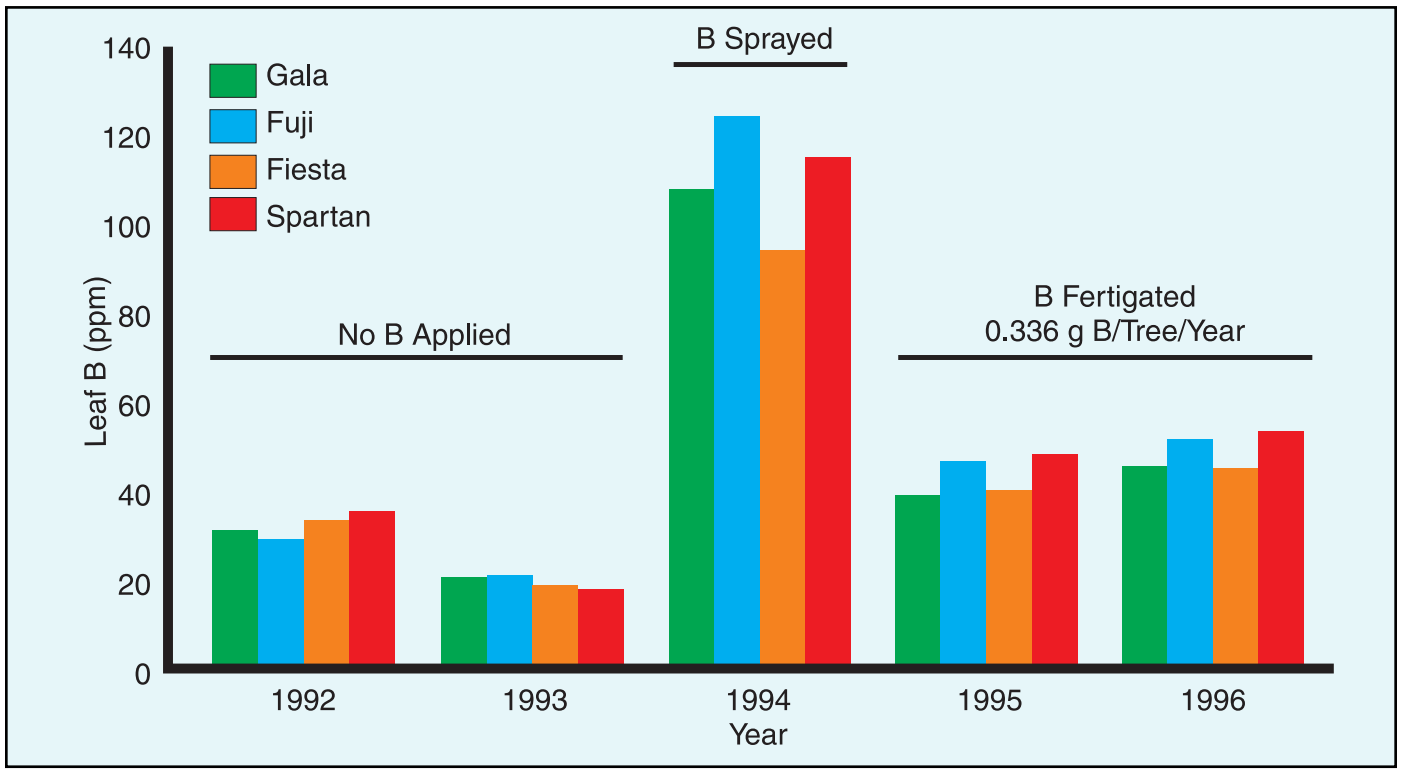

Figure 1. Effect of various B treatments on leaf B concentration for four cultivars from 1992 to 1996 (dotted line shows 20 ppm deficiency threshold).

acidification and correct K deficiency via fertigation. Inadequate leaf micronutrient concentrations have also been observed for high-density orchards receiving macronutrient fertigation, implying that strategies for maintenance of micronutrient nutrition are also important for these production systems. Micronutrient deficiencies, including B, have long been reported to potentially cause major growth problems for apples grown in traditional orchards of this region.

The objective of this study was to assess the effectiveness of fertigation to supply B for apple trees already receiving N and K via fertigation.

B management helps

Five years of N and K fertigation treatments tended to decrease leaf B concentrations with significant decreases observed as rate of fertigated N increased in 1992 and 1995, plus the addition of K fertigation the last three fruiting years (1994 to 1996). These relative decreases in leaf B concentration likely resulted from dilution due to growth stimulation, especially by K fertigation. Cultivar consistently affected leaf B concentration with highest annual leaf B concentrations measured for 'Fuji' and 'Spartan' cultivars from 1994 to 1996 (Figure 1).

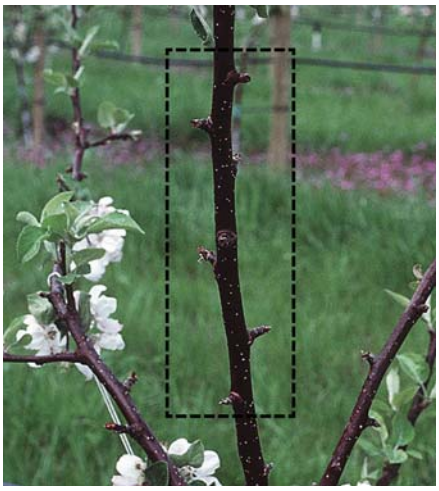

Figure 2. 'Blossom blast' symptoms (indicated by dashed box) as observed in spring of 1994 on apple trees in the experimental block.

Boron nutrition was managed differently throughout the study with no B applications in the first two years. In 1992, leaf B concentrations were generally low to adequate, regardless of cultivar, and by 1993 leaf concentrations were near or below 20 ppm (Figure 1), considered a deficiency threshold for apple. Susceptibility toward B deficiency has long been recognized in orchards of the semi-arid, fruit growing region of the Pacific Northwest where B additions via organic matter mineralization or precipitation are minimal. These results confirm a recent survey of drip-irrigated and NP-fertigated apple orchards that found possibly deficient leaf B concentrations in more than half of the surveyed locations. Leaf B deficiency occurred rapidly within two years in our research study on a sandy soil, paralleling the situation in grower orchards where problems occurred after only two to five years of NP fertigation, and where lowest extractable soil B values were measured in orchard soils with a high content of sand.

In the spring of 1994, classic B deficiency symptoms were observed as 'blossom blast' on a small percentage of flowers on all cultivars but not on all trees throughout the experimental block (Figure 2). This disorder involves drying and shriveling of flowers at bloom and is distinguishable from frost damage by the longer retention time of the damaged tissue on the tree. Two foliar B sprays were subsequently applied in early May and mid-June, resulting in contaminated leaves and high leaf B concentrations by mid-summer of 1994 (Figure 1). Maintenance of B nutrition by foliar sprays is a standard commercial recommendation in interior British Columbia orchards and was apparently

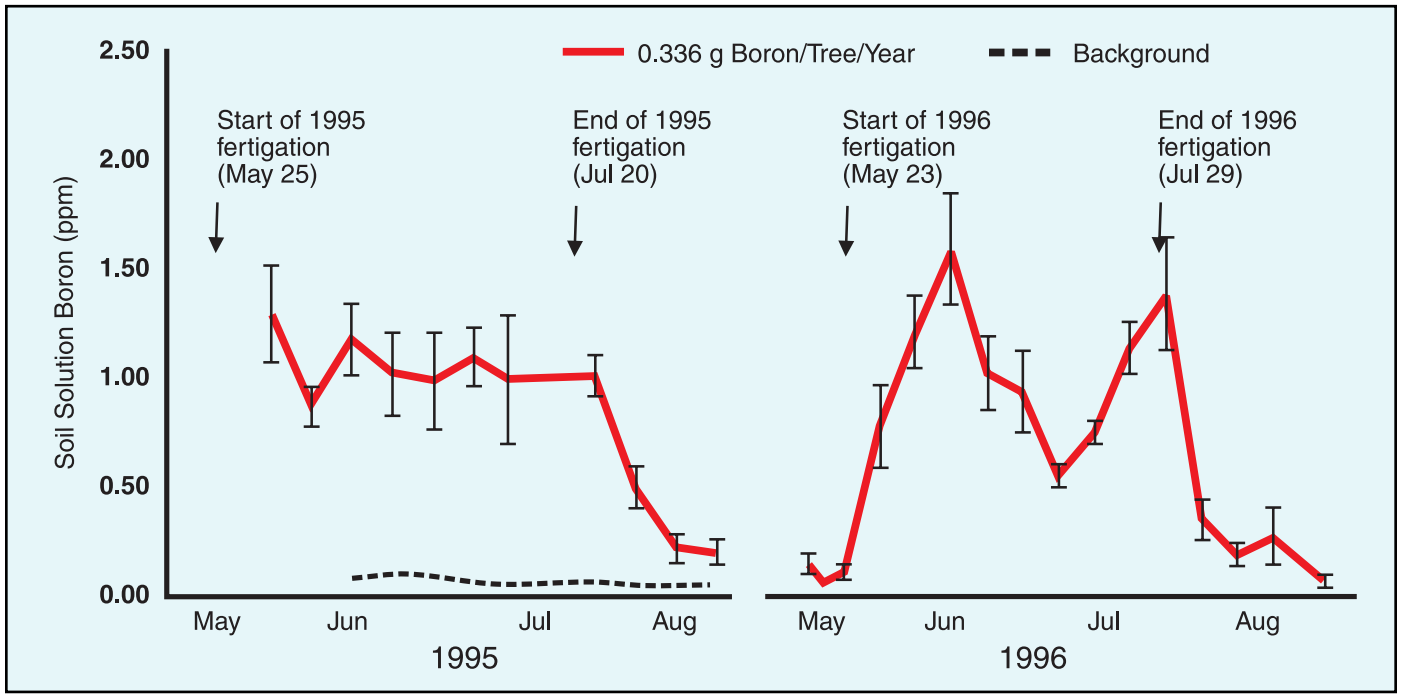

Figure 3. Soil solution concentration of B as influenced by fertigation for 0.34 g B tree in 1995 and 1996.

effective as no B deficiency symptoms (such as corking and cracking of skin surfaces as observed in 1993) were observed on fruit harvested in the fall of 1994.

Fertigation of 0.34 g B per tree increased soil solution B concentrations at 12-inch depth to values exceeding 1 ppm from background values less than 0.1 ppm soon after commencement of B fertigation in both 1995 and 1996 (Figure 3). Soil solution B concentrations returned to background values within two to three weeks after cessation of fertigation. The responsiveness of soil solutions B values to B fertigation is therefore similar to the responsiveness of soil solution NO3-N concentration to N fertigation. Like N, fertigated B is mobile within the soil and is anticipated to be similarly effective for plant uptake as fertigated N.

Leaf B concentrations in 1995 and 1996 were well above deficiency and within the sufficient-optimum range for apples (31 to 60 ppm) for all cultivars. In general, leaf B concentration also increased for all cultivars between 1995 and 1996, suggesting a need to be cautious of plant B status when supplying B by fertigation in order to prevent over-application. The narrow margin between B toxicity and deficiency for fruit trees was recognized during early work on B deficiency. More recently research has suggested bud damage when leaf B concentrations exceed 60 ppm. There has been little fertigation research for micronutrients such as B on fruit trees, although the possibility has been recognized. Our results from 1995 and 1996 indicate that it is possible to supply B nutritional needs of apple via fertigation but vigilance is required to avoid B toxicity.

Conclusions

Evidence from this experimentation on high-density apple orchards indicates that deficiency of B, which has been observed for standard low-density orchards receiving broadcast fertilizer applications, is likely to develop rapidly when trees are fertigated with macronutrients N and K. Deficient leaf B concentrations occurred within two years on a range of fertigated apple cultivars planted in typical coarse-textured orchard soils and grown under environmental conditions typical of the semi-arid fruit-growing region of the Pacific Northwest of North America. Fertigated B was mobile within the soil and it was relatively easy to increase leaf and fruit B to adequate concentrations via fertigation of modest rates of 0.34 g B per tree. This information suggested strategies on B management would be applicable to most apple cultivars grown under similar production conditions.

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