Timing of Nutrient Applications in Apple Orchards Using Fertigation

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During a growing season, fruit trees use nutrients taken up by the roots and nutrients remobilized from previous years of uptake to support the growth of new tissues. The timing of uptake likely determines whether or not a nutrient is partitioned to the fruit. In studies conducted at the Pacific Agri-Food Research Centre in Summerland, the effect of timing of B and K applications on tree nutrition and fruit nutrient concentration has been assessed. Fertigation (applying nutrients through an irrigation system), is a method of nutrient supply which offers great flexibility in timing of applications.

Surveys of British Columbia (B.C.) apple orchards receiving drip irrigation have shown that certain nutrients may rapidly become depleted in coarse textured soils. Boron (B) and potassium (K) are two of the nutrients most susceptible to depletion, and B and K deficiencies have been identified in high density apple plantings in B.C. However, both nutrients have been reported to cause a reduction in storage quality if found in high concentration within the fruit.

In sandy soils with low organic matter content, B availability is closely related to B concentration in the soil solution. Soil solution B can be increased through fertigation and availability controlled quite precisely during the year (**Figure 1**). This is reflected in both leaf and fruit B concentrations (**Figure 2**). In 1996, trees received 0.012 oz. B/tree/year which resulted in high leaf B concentrations which were well above the critical level for deficiency...20 parts per million (ppm), but below the critical level for toxicity (60 ppm). Fruit B concentration was also high. In 1997 and 1998, a lower amount of B was applied either in spring or fall or not at all (as illustrated in **Figure 1** for 1998). Both leaf and fruit B levels were lower in response to the lower B rate. Leaf B levels fell below the critical value for deficiency the second year after B applications were ended, indicating a rapid decline in the tree and soil B storage pools. Fall application of B kept leaf B concentration above the deficiency level and also resulted in low fruit B levels. Thus, fall applications maintained tree B status without endangering fruit quality.

A similar experiment with timing of K applications had very different results. Potassium was applied at the rate of 1.06 oz. K/tree, either in spring-early summer, early-mid summer, or not at all. Because late applications of nitrogen (N) may have detrimental effects on tree winter hardiness, early K plots received K as potassium nitrate (KNO_3) and late K plots received K as potassium chloride (KCl). Nitrogen was supplied at the rate of 1.41 oz. N/tree/year either as ammoni-

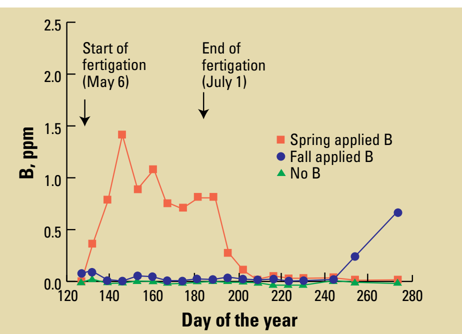

Figure 1. Soil solution B concentration in response to timing of application.

um nitrate (NH_4NO_3)...control and late K plots...or as KNO_3 plus NH_4NO_3 (early K plots).

Monitoring of soil solution K concentrations revealed an unexpected response to K applications (**Figure 3**). Plots receiving late K had very high K concentrations early in the growing season, prior to K application. It is surmised that as these plots were receiving half of their N in the ammonium form, there was considerable exchange of the added ammonium (NH_4) for K, which had been adsorbed by the soil the previous year.

In the early application treatments, soil solution K concentrations rose steadily after fertigation commenced in early June and were highest at the end of the fertigation period, suggesting a gradual saturation of soil cation exchange sites. Plots receiving no K had consistently lower soil solution K concentrations than plots fertigated with either KCl or KNO_3.

Potassium concentrations in leaves reflected the soil solution data (**Figure 4**). Timing of K supply had no effect on leaf K concentration, but trees receiving no K had consistently lower leaf K concentrations from 1996 to 1998. These findings suggest that precise timing of K applications to meet plant requirements may be particularly difficult if NH_4 based fertilizers are used to supply N. No trees had leaf K concentrations below the 1.2 ppm critical value for K deficiency. Except in 1997, when both application of K and timing of applications affected fruit K nutrition, there were no significant effects of K applications on fruit K concentrations (**Figure 4**). (Note: FW is abbreviation for fresh weight.)

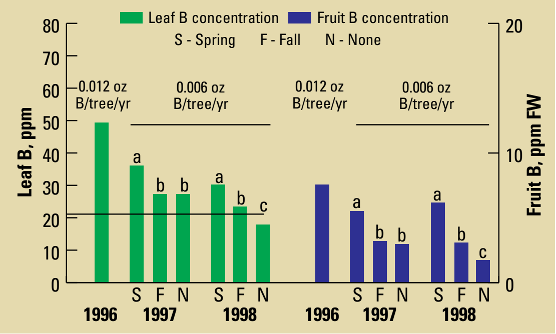

Figure 2. Leaf and fruit B content in Jonagold/M.9 apple trees in response to timing of B application.

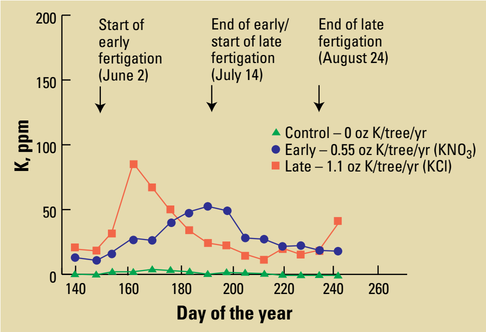

Figure 3. Soil solution K concentration in response to timing of K application in 1997.

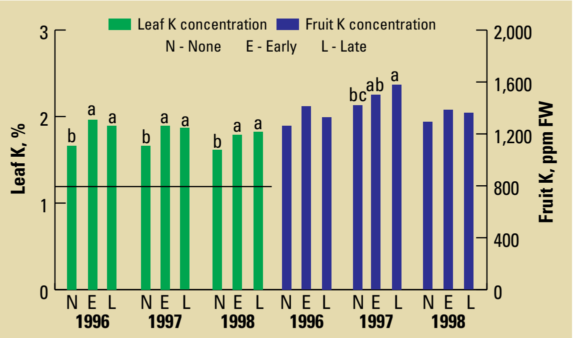

Figure 4. Leaf and fruit K content in Jonagold/M.9 apple trees in response to timing of K application.

The success of timing of nutrient applications to meet plant requirements for growth, while controlling fruit nutrient concentrations in order to maintain fruit quality, may depend on the mobility of the nutrient in the soil. Mobile nutrients such as B are easier to manage than nutrients such as K which are adsorbed by soil. Adsorbed K may be replaced by other fertilizer nutrients such as NH_4 and thus become more available during times when it is not being applied than in times when it is being applied. BC

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