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Seasonal Variation of Leaf Nutrient Composition in 'Tifblue' Rabbiteye Blueberry[1]

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***Abstract*. 'Tifblue' rabbiteye blueberry (*Vaccinium ashei* Reade) leaves were sampled at 2-week intervals during the growing seasons of 1979 and 1980. Each sample was analyzed for 5 macronutrients and 5 micronutrients. Prediction equations for the estimation of nutrient element content on a growing season basis were calculated. Leaf elemental content patterns correlated closely between years with the exception of Fe. Leaf elemental N, P, and Zn were highest in the early season, tended to decrease until harvest, and leveled off as the growing season progressed. The levels of leaf Ca and Mg remained relatively constant through the season with lowest percentages present during harvest. Leaf contents of K, Mn, and to a lesser extent B and Na, were high during April and early May, low during harvest, and high again in October. Regression analyses for most elements were more linear from late June to early August. Therefore, optimum time for the collection of leaf samples of rabbiteye blueberries for mineral analyses appears to be a 4-week interval coinciding with the last 2 weeks of the harvest season through a 2-week period immediately following harvest.**

The nutritional status of many small fruit crops can be diagnosed by leaf mineral analysis. Seasonal changes in the foliar elemental concentration of nutrients have been reported for highbush and lowbush blueberries (*Vaccinium corymbosum* L.) by several workers (1, 2, 3, 5, 6, 10, 11). Chuntanaparb and Cummings (6), in a study on seasonal trends of leaf-nutrient concentrations, reported that macronutrient content was lower in highbush blueberries than in other crops tested. Also, nutrient concentration differences between leaf portions (margin vs. blade) were generally much less in blueberry than in other species tested. Ballinger (2) stated that leaf macronutrient components of 'Wolcott' highbush blueberry followed relatively predictable seasonal patterns and the optimum time for leaf sampling of highbush blueberry appears to be the 2–3 week period immediately after harvest. Bailey et al. (1), working with 'Rubel' highbush blueberry, reported that seasonal curves of N, P, K, Mg, and Ca in the leaves were similar to those for late apples and 'Elberta' peaches with the exception of a late season K increase in blueberry leaves. They stated that leaf sampling just before fruit ripening was probably most desirable.

In most fruit crops, foliar contents of the macro- and micronutrients vary with the time of season. Since the rabbiteye blueberry industry is relatively young, little research on mineral nutrition has been reported. The objective of this study was to determine seasonal changes in leaf nutrient content of rabbiteye blueberries for use as a base in developing methods for diagnosing nutrient deficiencies and/or nutrient imbalances.

Materials and Methods

Leaf samples were collected at random from 3 representative 'Tifblue' rabbiteye blueberry plots, all located on Typic Ochrultic soils with pH ranges of 4.8 to 5.2. Plants at all locations had been established for 5–8 years at the initiation of this study. Fifty leaves per sample were taken at approximately 2-week intervals during the 1979 (April 2 – September 20) and 1980 (April 28 – November 28) growing seasons. Samples consisted of the 4, 5, or 6 positioned leaves from branch terminals. Dried, finely ground leaf samples were analyzed by the Plant Analysis Laboratory, University of Georgia, Athens. Elemental analyses were by emission spectroscopy and N by Kjeldhal. Prediction equations for the estimation of nutrient element content on a growing season basis were calculated. Data from both years were pooled and the highest significant regression equation (linear, quadratic, or cubic) was used to compare the concentration of each element (Y) vs. sampling time (X) recorded as Julian dates for each element analyzed.

Results and Discussion

Nitrogen. Percentage of leaf N was highest in the early sampl-

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ing dates and decreased throughout the growing season (Fig. 1). Nitrogen leaf content followed the cubic regression equation Yc $= 8.2478 - 0.08364X + 0.336\cdot10^{-3}(X^2) - 0.45\cdot10^{-6}(X^3)$ where Y = % N in leaves and X = Julian date (JD) during growing season. The rate of decrease was more rapid between April 10 and May 30 (100 and 150 JD) with a drop of 1.04% N. Between May 30 and July 19 (150 and 200 JD) the decrease in N was 0.36%. Leaf samples collected after July 19 through October 27 exhibited little change in percent N, decreasing only 0.02% between the 200 and 300 Julian sampling dates. The July 19 (200 JD) date corresponds to the end of the harvest season whereas harvest can begin as early as the first week in June (8). Percent leaf N followed similar cubic relations with time in both 1979 and 1980. The seasonal curve for N in rabbiteye blueberries is similar to that reported for highbush and lowbush blueberries (1, 2, 6, 10, 11). Since the regression curves for percent N in rabbiteye blueberry leaves start to level off after July (end of harvest season) this would be a logical time to collect leaf samples for the determination of N.

Phosphorus. Percent P was highest in leaves early in the growing season, following similar patterns for both years (Fig. 1). Phosphorus content decreased rapidly until harvest, leveled off during the harvest season, and then increased slightly through the remainder of the growing season, following the cubic regression equation Yc $= 1.0058 - 0.1259\cdot10^{-1}(X) + 0.547\cdot10^{-4}(X^2) - 0.76\cdot10^{-7}(X^3)$. Curves were similar to those for highbush blueberries reported by Ballinger (2) and Trevett et al. (11) for lowbush blueberries but differed from the Bailey et al. (1) highbush study only in the increase at the later stages of the growing season. Since little change occurred from May 30 to October 27 (150 to 300 JD) there is a long period during which comparable leaf samples for P could be obtained.

Potassium. The general trend of leaf K content was similar for both years. Leaf K content was high at the start of the growing season, decreased to a low during harvest, then increased as the season progressed (Fig. 1). Changes in potassium leaf content fit a cubic regression equation Yc $= 2.7970 - 0.3556\cdot10^{-1}(X) + 0.165\cdot10^{-3}(X^2) - 0.24\cdot10^{-6}(X^3)$. The late season increase in leaf K in rabbiteye blueberry also occurs in highbush blueberries (1, 2) but not in lowbush blueberries (11). The harvest period appears to be the optimum time for sampling leaves for K content.

Calcium. Leaf calcium content followed a quadratic regression curve Yq $= 0.3999 - 0.1696\cdot10^{-2}(X) - 0.450\cdot10^{-5}(X^2)$ (Fig. 1). Calcium was lowest during the harvest season and the period immediately after harvest. Leaf Ca levels fluctuated less than N, P, and K throughout the growing season, varying only 0.055%, thus indicating a potentially long sampling period. Calcium content varied between years with an average of 0.5% more Ca present in 1979 than 1980. Calcium content of rabbiteye blueberries differed from that reported for highbush and lowbush blueberries in which Ca was lowest at the beginning of the season and tended to increase as the season progressed (1, 2, 11).

Magnesium. The seasonal changes in Mg content of the leaves were small, with an overall variation of only 0.046% from highest to lowest percentage and showed close agreement between years. Magnesium content was lowest during harvest and tended to increase late in the growing season (Fig. 1). The regression curve of Mg was similar to that of Ca and followed the quadratic equation Yq $= 0.3618 - 0.1329\cdot10^{-2}(X) - 0.359\cdot10^{-5}(X^2)$. Like Ca, leaves could be sampled over a long period of time with optimum sampling during or immediately after harvest.

Manganese and sodium. Mn and Na followed similar cubic regression curves with both being present in highest leaf concentrations during the early sampling dates and then decreasing rapidly until harvest (Fig. 2). Manganese content (Yc $= 1567.2381 - 19.6542X + 0.775\cdot10^{-1}(X^2) - 0.89\cdot10^{-4}(X^3)$, Y in PPM) then accumulated rapidly in the leaves until the end of the growing season. Sodium, following the cubic equation Yc $= 1717.1446 - 23.5239X - 0.105X^2 - 0.15\cdot10^{-3}(X^3)$, also increased in the leaves after the harvest season but at a much slower rate and tended to level off near the end of the season. Optimum sampling time for Mn and Na appears to be near the end of the harvest season.

Boron and Zinc. Leaf content of B and Zn was highest at the first sampling date, decreased until harvest and increased after harvest to the end of both growing seasons (Fig. 3). Both elements followed cubic regression equations; Yc $= 131.707 - 1.5636X + 0.675\cdot10^{-2}(X^2) - 0.90\cdot10^{-5}(X^3)$ for B and Yc = 105.019 –

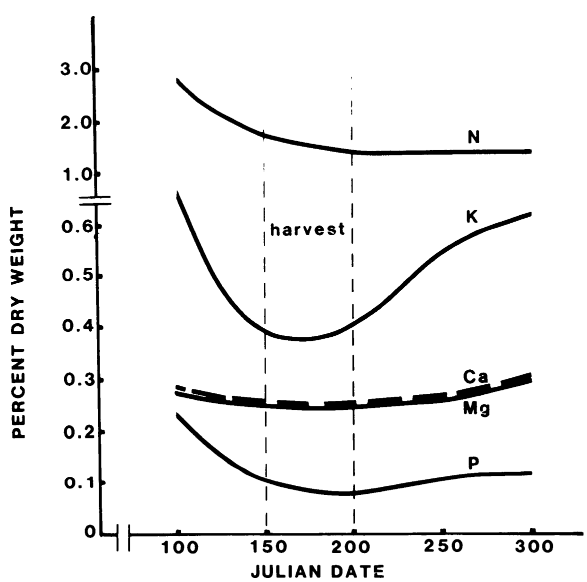

Fig. 1. Seasonal N, P, K, Ca, and Mg content regression curves in 'Tifblue' rabbiteye blueberry leaves, significant at the 5% level.

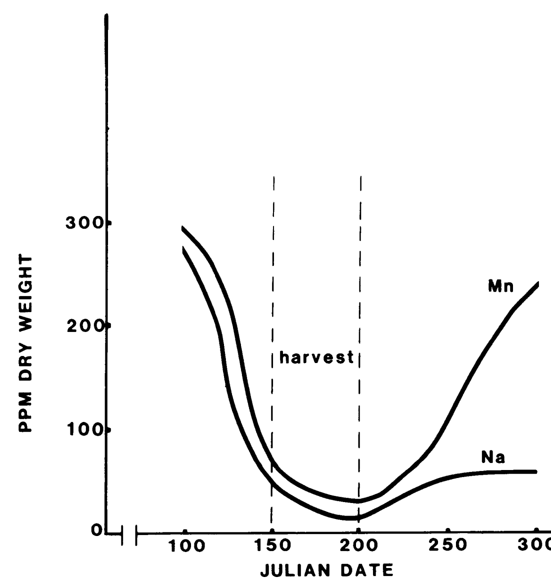

Fig. 2. Seasonal Mn and Na content regression curves in 'Tifblue' rabbiteye blueberry leaves, significant at 5% level.

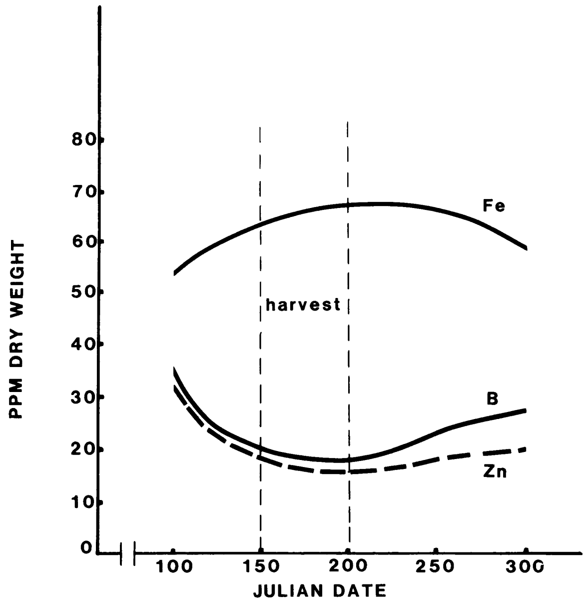

Fig. 3. Seasonal B, Fe, and Zn content regression curves in 'Tifblue' rabbiteye blueberry leaves. B and Zn significant at 5% level. Fe significant at 10% level.

$1.1702X + 0.493 \cdot 10^{-2}(X^2) - 0.66 \cdot 10^{-5}(X^3)$ for Na (Y = PPM dry weight, J = JD). Curves for B and Zn begin to level off around the first of June and stay relatively constant until the last of July, indicating an optimum sampling period during and immediately after harvest.

Iron. Iron was the most erratic of the elements measured, not fitting any regression curve at the 0.05 level. The seasonal pattern of Fe at the 0.10 level followed a quadratic curve $Yq = 15.5447 + 0.4897X - 0.146 \cdot 10^{-2}(X^2)$ (Fig. 3). Iron was the only element that was lower at the beginning of the season, increased until after harvest, then decreased. Compared to highbush blueberries, rabbiteye blueberries have been reported to be inefficient in Fe uptake when placed under Fe stress since H+ ions were not released from its roots to make Fe more available for use and transport from roots to top (4). Eaton and Meehan (7) indicated no differences in Fe leaf content between highbush blueberries sampled in June and August but both sampling dates resulted in higher PPM of Fe than data reported in this study.

The uptake of iron can be greatly influenced by relatively high concentrations of competitive ions, such as Ca, in the soil or nutrient solution (4, 9). This may explain the increase of Fe uptake during the period when the uptake of other nutrients was at their lowest levels.

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