Elemental Composition of Red Raspberry Leaves as a Function of Time of Season and Position on Cane[1]

Megan Hughes,[2] M.H. Chaplin,[2] and A.R. Dixon[2]
Oregon State University, Corvallis, Oregon 97331

Additional index words. Rubis idaeus, leaf analysis, plant nutrition

Abstract. Leaves of red raspberry (*Rubus idaeus* L. cv. Meeker) were sampled every 2 weeks throughout the growing season at 7 different positions on the cane to determine the time and position of minimum leaf nutrient flux. During the last half of August, the 5th to 12th leaves from the terminal 15 cm of the primocane showed the least variation in nutrient concentrations.

Fig. 1. Schematic drawing of red raspberry cane, showing 7 positions sampled.

Leaf analysis is used to identify nutritional level in a wide variety of crops. However before it can be successfully used as a diagnostic tool the effect of genotype, sampling date, and leaf age on leaf nutrient composition must be known.

The influence of non-nutritional factors on leaf composition of red raspberries was investigated in British Columbia (3,4). In the first study, the youngest mature leaves of the primocanes were sampled and it was found that plant age did not significantly influence elemental concentrations, while date of sampling and genotype caused wide variation. In the second study leaf element composition was determined from both new and old fruiting canes in 8 red raspberry clones and it was found that genotype, cane age, and sampling time affected leaf levels. New canes appeared to be the sampling tissue of choice because of higher levels of the macroelements and since they would bear the next seasons crop.

A similar study in Oregon, using the youngest mature red raspberry leaves, produced such variable results that no conclusions could be drawn (Chaplin, unpublished). It was decided that the choice of "youngest mature leaf" was too subjective and a more precise method of leaf selection was required. This study was undertaken to determine how elemental composition of leaves at specific positions varied through the season. Both leaf position and a period of the season could then be specified for more accurate diagnostic leaf sampling.

Leaf samples were taken from canes of 'Meeker' red raspberries every 2 weeks from July 16 to September 9, 1974. Each sample was taken from 3 moderate-sized canes (0.8 to 1.3 cm diam at the base, about 180 cm tall) selected at random from the south side of one row. A separate row was used for each 20 replications. The canes were divided into 7 positions and leaves from all 3 canes were combined at each position. Sampling positions were the top 15 cm of the cane, measured from the tip of the longest leaf (this included the terminal and several unexpanded leaves), and positions at each successive 2 leaves down the cane (Fig. 1).

Emission spectroscopy was used to measure K, P, Ca, Mg, Mn, B, Cu, and Zn (1). Modified Kjeldahl (6) was used to determine N levels.

Leaf concentration of N, P, and K were highest in the younger leaves and generally decreased in older leaves (Fig. 2). N, P, and K also declined in concn at most positions through the season, especially in older leaves (positions 4-7). These concentration decreases could have resulted from growth dilution as the leaves increased in dry weight (2). Similar results have been obtained with red raspberry and other crops, generally accompanied by an increase in total N, P, and K taken up by the leaves (4,5,7). Total uptake of nutrients was not measured in this study. Translocation of nutrients to apical areas could also account for the concentration decrease.

Concentrations of Ca and Mg were highest in older leaves and lowest in younger leaves (Fig 2). Concentrations of Ca at position 7 and Mg at positions 2-4 decreased through the season. This is consistent with observations on other crops (7) but opposite from that previously reported for red raspberry w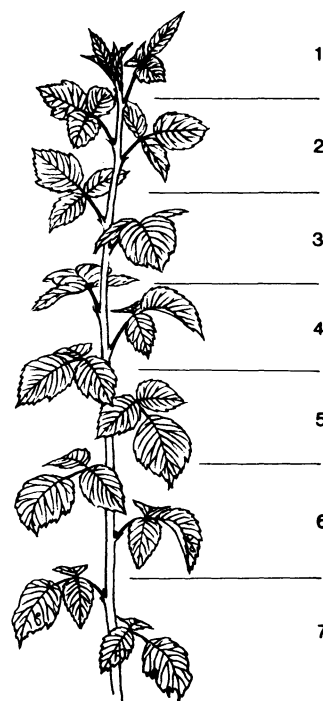hich indicated an increase in Mg concentra-tion as the season progressed (4). Manganese concentrations were lowest at positions 1 and 2 throughout the season, but not always significantly lower (Fig. 2). There was little difference in Zn concentration at the various positions on any one sampling date (Fig. 2). Zinc increased greatly through the season, whereas Mn decreased. Leaf B decreased from younger to older leaves (Fig. 2). Levels at positions 4-7 remained nearly constant through the season, while younger leaves showed considerable fluctuation in B concentration. Copper concentration was variable, with older leaves sometimes slightly higher in this element (Fig. 2).

At the last sampling date, the concentration of N, P, K, and Ca showed a sharp upturn. This was probably due to rain in early September, which may have caused the plants to resume growth and nutrient uptake, or may have made soil nutrients more available. Normally, the concentrations of these elements would be expected to decline through out the growing season (7).

The period of least flux of nutrient concentrations occurred in the last 2 weeks of August. This corresponded to a decline in rapid growth and, by the end of August, the set of some terminal buds. The best correlation of leaf composition with plant nutritional status occurs when the internal nutrient flux is at a minimum (7); thus, the last half of August seems to be the best time to take leaf samples of red raspberries.
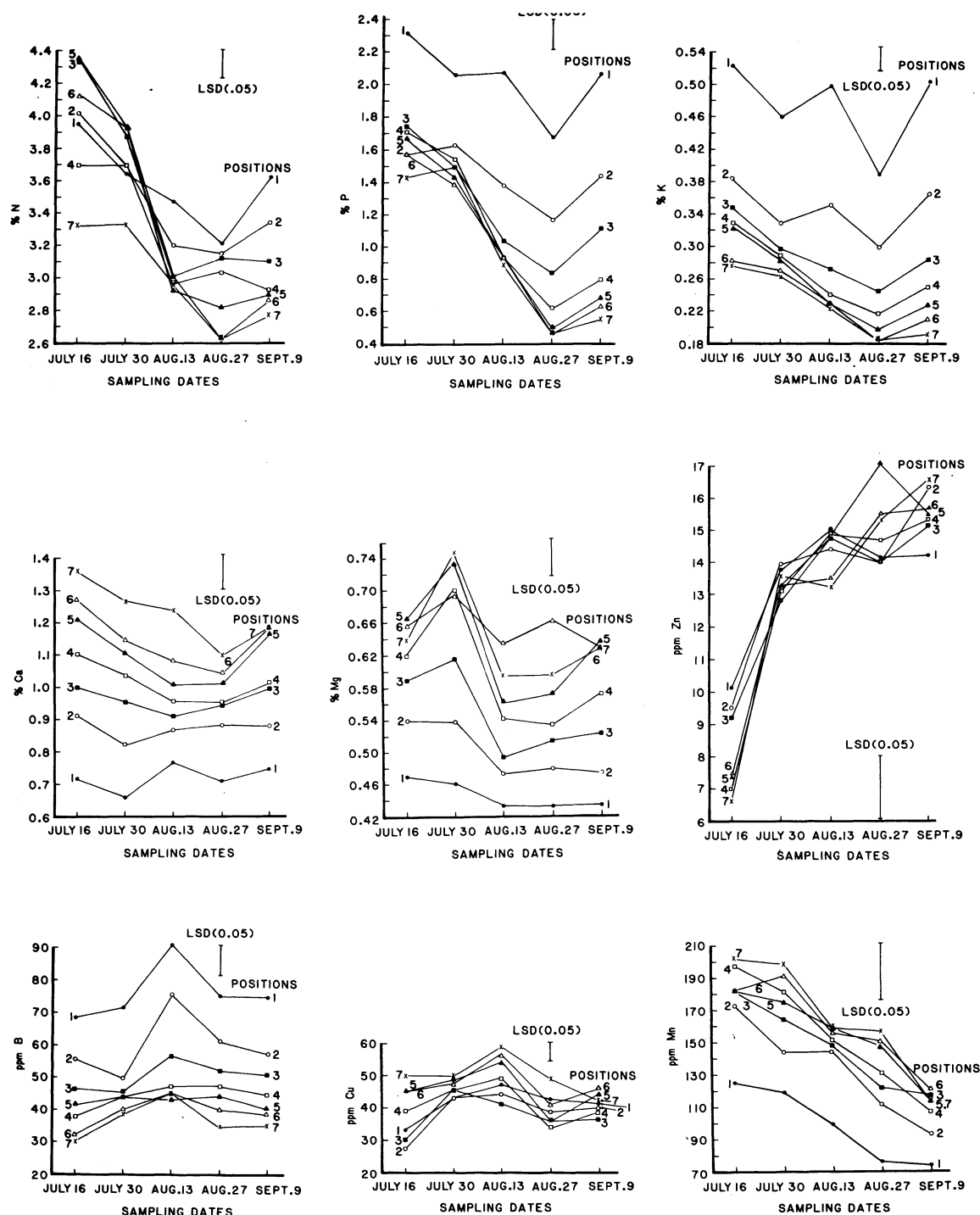
Fig. 2. Elemental concentration (dry weight basis) of leaves at different positions as a function of sampling time.

Differences between nutrient levels of leaves from position 1-3 tended to be great at all sampling dates, but there was less difference in nutrient levels between positions 4-7. There would thus be less chance of variation due to position of leaf sampled by choosing leaves from positions 4-7 (leaves 5-12 from the terminal 15 cm). This specification overcomes the problem of subjectivity in deciding which is the "youngest mature leaf."

Literature Cited

1. Chaplin, M. H. and A. R. Dixon. 1974. A method for analysis of plant tissue by direct reading spark emission spectroscopy. *Appl. Spectrosc.* 28:5-8.
2. Emmert, F.H. 1959. Chemical analysis of tissue as a means of determining nutritional requirements of deciduous fruit plants. *Proc. Amer. Soc. Hort. Sci.* 73:521.
3. John, M. K. and H. A. Daubeny. 1972. Influence of genotype, date of sampling and age of plant on leaf chemical composition of red raspberry (*Rubus idaeus* L.). *J. Amer. Soc. Hort. Sci.* 97:740-42.
4. John, M. K., H. A. Daubeny, and H. H. Chuah. 1976. Factors affecting elemental composition of red raspberry leaves. *J. Science Food & Agric.* 27:877-882.
5. McClung, A. C. and W. L. Lott. 1956. Mineral nutrition and composition of peach leaves as affected by leaf age and position and the presence of a fruit crop. *Proc. Amer. Soc. Hort. Sci.* 67:113.
6. Schuman, G. E., M. A. Stanley, and D. Knudsen. 1973. Automated total nitrogen analysis of soil and plant samples. *Soil Sci. Amer. Proc.* 37:480-81.
7. Smith, P.F. 1962. Mineral analysis of plant tissues. *Ann. Rev. Plant Physiol.* 13:81-108.