Patterns of Nutrient Accumulation in 'Hass' Avocado Fruit

By Richard Rosecrance, Ben Faber, and Carol Lovatt

Synchronizing plant nutrient demand with fertilizer application increases nutrient use efficiency, is cost-effective, and protects the environment. Avocado trees were sampled during their 2-year growing cycle to determine the pattern of nutrient accumulation in the fruit as a guide for better timing of fertilizer applications.

An understanding of seasonal nutrient requirements of crops is important in order to develop best fertilizer management practices. 'Hass' avocado trees absorb nutrients according to seasonal growth patterns, and matching fertilizer applications to those patterns can maximize yields, improve fruit quality, increase nutrient uptake, and reduce the potential for nutrient loss.

Avocado fruit is unique because it remains on the tree for 15 to 18 months after spring bloom (i.e. two growing seasons) and the developing fruit is a strong sink for nutrients (**Figure 1**). Fruit N removal values in the literature range from 11 to 61 kg N/ha based on a 10 t/ha crop yield. However, little is known about the pattern of nutrient uptake into avocado fruit. This understanding is important to schedule fertilizer applications to coincide with periods of high nutrient demand, thereby maximizing nutrient use efficiency.

Research was conducted in a commercially bearing mature 'Hass' avocado orchard growing on a gravelly loam (thermic Typic Argixerolls) in Moorpark, California. Fruit samples were harvested monthly for 1 year from two different trees each month. The total fruit weight and number of fruit per tree were determined as were the concentrations of specific nutrients in the tissues of fruit.

Avocados are grown in more than 60 countries. The Hass variety (shown here) is the most common, but other locally adapted varieties are also cultivated.

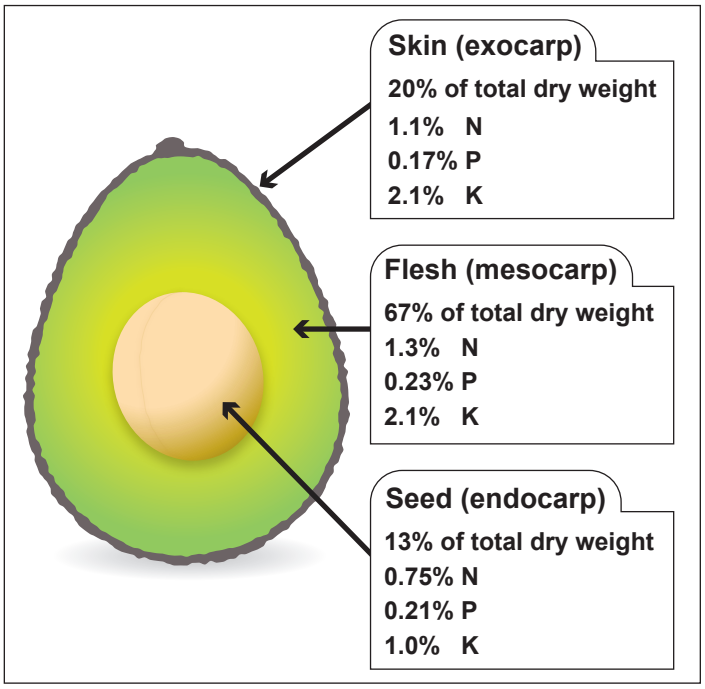

Figure 1. The dry weight and nutrient content (dry weight basis) of mature avocado fruit skin, flesh, and seed.

Common abbreviations and notes: N = nitrogen; P = phosphorus; K = potassium; S = sulfur; Mg = magnesium; Ca = calcium; B = boron.

Dry Weight and Nutrient Accumulation Patterns

Fruit dry matter accumulation followed a double sigmoid curve (**Figure 2**). Fruit growth was split evenly over the 2 years, with about half of the total fruit dry weight accumulating during the first growing season and half accumulating the following year. Dry matter accumulation ceased during the winter months (i.e. December to March). This differs from avocados growing in tropical environments where fruit growth follows a single sigmoid curve.

Similar to the dry matter growth curve, avocado fruit accumulated most nutrients in a double sigmoid pattern with nutrient uptake ceasing during the winter months (**Figure 3**).

Accumulation patterns, however, differed for the individual nutrients. Approximately 50% of the total fruit nutrient uptake for N, P, Mg, and S occurred during the first year and 50% accumulated during the second growing season. In contrast, only about 30% of the total fruit K and B accumulated during the first year, and the remaining 70% accumulated during the second growing season. In contrast to other nutrients, fruit Ca content followed a single sigmoid curve, where it increased during the first 5 months following bloom and then remained constant until fruit harvest in September the next year (**Figure 2**).

Timing Fertilizer Applications to Meet Tree Nutrient Demand

Avocado fruit accumulated the majority of nutrients between full bloom and autumn and also during the following spring. These periods of high fruit nutrient demand should coincide with timely fertilizer applications. For example,

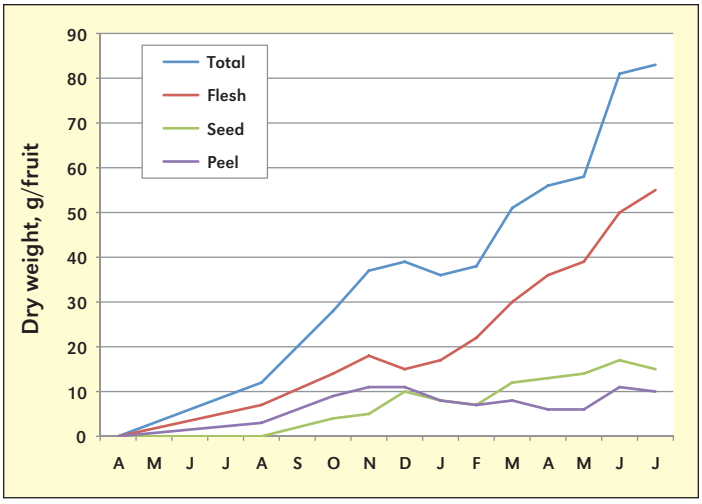

Figure 2. Dry matter accumulation in an avocado fruit from bloom to harvest.

in earlier experiments N fertilization in the spring (April) increased both fruit size and yield and reduced the severity of alternate-bearing compared with trees receiving N at any other time of the year besides April. April N fertilization appears to be critical for fruit set of the new crop, for growth of the vegetative shoot flushes, and to support fruit growth of the maturing crop.

Fertilizer applications at the very least must replace nutrients removed in fruits to avoid soil depletion. In this study, primary and secondary nutrient removal by a 10 t/ha avocado crop was (kg/ha) 22 N, 30 K, 4 P, 5 S, 1 Ca, and 3 Mg (**Table 1**). Other factors in the orchard will also influence crop nutrient removal, such as rootstock, scion cultivar, and tree age.

To synchronize fruit nutrient demand with fertilizer application, we recommend for:

N, P, Mg, S, Fe, and Zn – Apply these nutrients during the Spring growing season after full bloom and repeat again the second year during the same time period. This strategy supplies nutrients to the recently pollinated flowers as well as the maturing fruit.

K and B – These nutrients are accumulated more rapidly during the second season of fruit development. Depending on the fruit load, a higher application rate may be needed to support the maturing fruit.

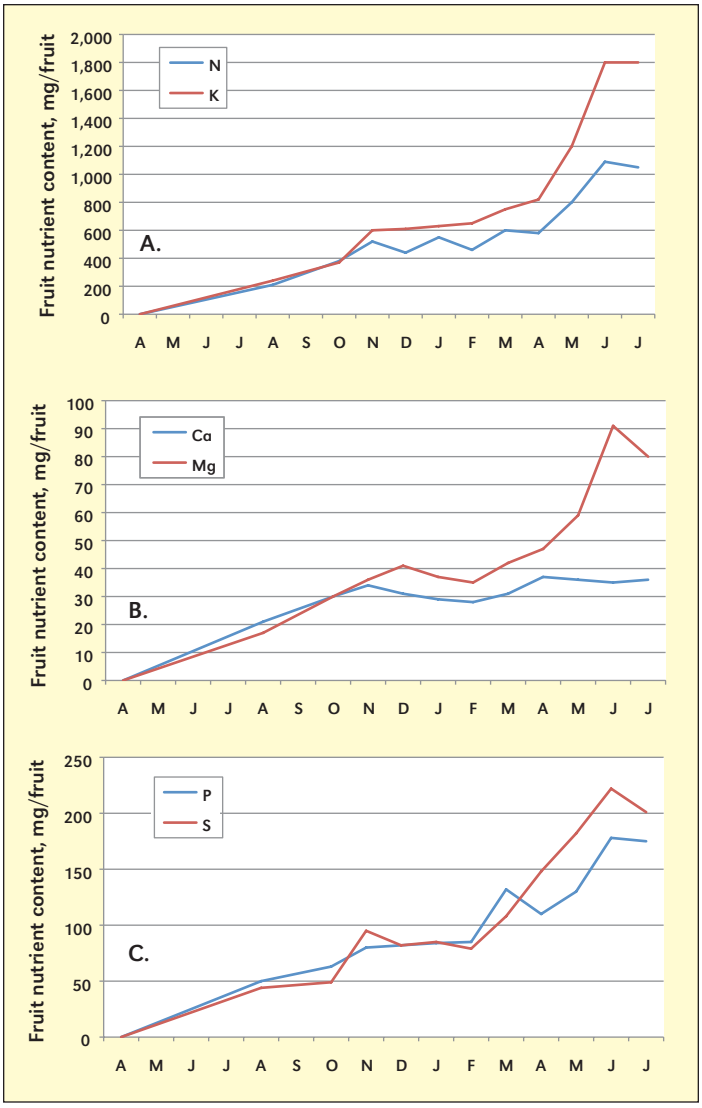

Figure 3. Accumulation of selected nutrients in 'Hass' avocado fruit from bloom to harvest. Uptake patterns are shown for N and K (A), Ca and Mg (B), and P and S (C).

Ca – Since most of the Ca was accumulated during the first year of fruit growth, an abundant supply must be available during early fruit development.

Table 1. Nutrients removed from an avocado crop based on a 10 t/ha yield†.

Nutrient	This study	Other literature‡	Nutrient	This study	Other literature‡
	kg/ha			g/ha	
N	22	11 to 41	B	192	401
P	4	2 to 10	Fe	45	47 to 212
K	30	20 to 61	Zn	67	45 to 156
S	5	4 to 8	Mn	12	9 to 47
Ca	1	2 to 7	Cu	29	10 to 58
Mg	3	4 to 8			

† Calculated on a fresh weight basis.
‡ Specific literature citations are available at http://info.ipni.net/BCADDENDA.

Synchronizing the timing of fertilizer applications with plant nutrient demand is critical for the successful production of avocado fruit. It is also important to consider the right fertilizer source, rate, and placement of the added nutrients in order to meet the desired economic and environmental objectives. BC

Dr. Rosecrance is an Associate Professor, College of Agric., Calif State Univ, Chico; e-mail: rrosecrance@csuchico.edu. Dr. Faber is a Farm Advisor in Ventura County, Univ. Calif., Dr. Lovatt is a Professor, Dept. Botany & Plant Sci. Univ. Calif., Riverside, CA.