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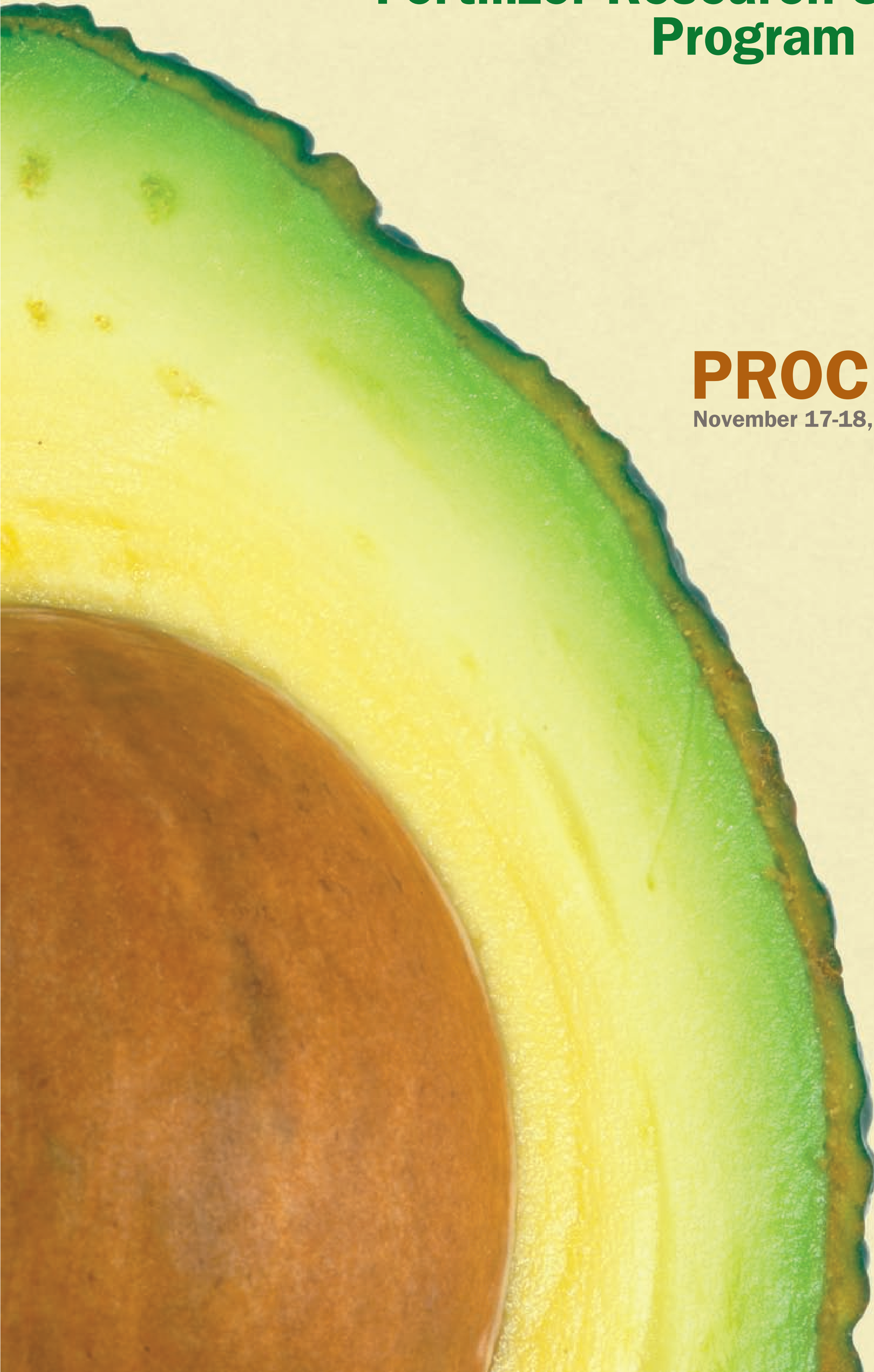

Matching Fertilizer Applications to Seasonal Growth Patterns in Avocado

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INTRODUCTION

This project focuses on developing best management fertilizer practices to improve nutrient use efficiency (yield per unit input of fertilizer) and reduce environmental pollution related to excessive fertilizer applications. For the 'Hass' avocado (*Persea americana* L.) industry of California, fertilization rates and optimal leaf nutrient ranges have been borrowed from citrus for all nutrients except nitrogen (N), zinc (Zn) and iron (Fe). Competition from Mexico, Dominican Republic, Chile, Australia, Peru, and South Africa requires the California avocado industry to increase production per acre to remain profitable. Optimizing fertilization is essential to achieve this goal.

The development of best management fertilizer practices is particularly important for alternate bearing avocado trees, for which most growers use the results of their August-September leaf analyses to replace nutrients used by the current crop. If not managed correctly, trees that are setting fruit in an off year receive more fertilizer than is needed. Over fertilization with nitrogen can significantly decrease avocado fruit size (Arpaia et al, 1996). Properly timing soil-applied nitrogen can increase yield and fruit size and reduce alternate bearing of the 'Hass' avocado.

We believe that the deliverables of this project will increase yield, fruit size and profitability for California's 6,000 avocado growers, while protecting the groundwater. Information on best management fertilizer practices will be supplied in two formats: 1) graphically—plots will be developed documenting the stage-to-stage (month-to-month) changes in the concentrations of each essential mineral nutrient in vegetative and reproductive organs for both on- and off-crop trees; and 2) dynamically—a computer-based fertilizer model will be developed. Computer-based fertilizer recommendations have been successfully adopted by growers for other crops (almond, pistachio, walnut, macadamia, etc.) and should be developed for avocado.

OBJECTIVES

1. Develop user-friendly phenological timelines reporting biomass accumulation and total nutrient uptake for specific reproductive structures and vegetative components.
2. Develop a computer program that growers can easily use to calculate their own fertilizer recommendations (nutrient, application time and rate) based on tree phenology, crop load, and vegetative growth calculations.
3. Trouble-shoot, and finalize the computer program and make it available on the web. Our computer-based approach involves mathematical data mining, graphic representation of results for ease of use, and development of the computer program.

DESCRIPTION

The primary investigators (PIs) recently completed the difficult task of quantifying nutrient partitioning during all stages of tree phenology by excavating on- and off-crop avocado trees every two months over two years at Somis Pacific in Moorpark, California. At excavation, trees were dissected into inflorescences, fruit, leaves, green shoots (<½ inches), small branches (½-2 inches), mid-size branches (2-4 inches), scaffolding branches (4-6 inches), wood (> 6 inches), scion trunk, rootstock trunk, scaffolding roots, small roots and new roots. Total weight of each component was recorded. Sub-samples were washed, dried, ground, weighed and analyzed for nutrient content of 12 essential elements.

A phenology and yield-based nutrient model will be developed for avocado from these tree excavation data. Uptake and partitioning of nitrogen and other nutrients into tree components in both on- and off-crop trees will be determined by the model. A basic fertilization model will be developed first, based on the nitrogen almond model (see Web site for model: http://ucce.ucdavis.edu/rics/fnric2/almondNKmodel/almond_n_model.htm). After discussions with growers and researchers, we will modify the program based on their recommendations.

RESULTS AND DISCUSSION

Fruit dry matter accumulation followed a double sigmoid curve (Figure 1). About half of the total fruit dry weight occurred between mid-May and mid-November and the remainder accumulated between mid-February until harvest in mid-July. During winter (November through February) little dry matter accumulation occurred. At fruit maturity, the flesh, seed, and peel comprised 67, 20, and 13% of the total fruit dry weight, respectively.

Similarly, nitrogen, phosphorus, and potassium (N, P, K) accumulation in fruit followed a double sigmoid pattern (Figure 2). Fruit nutrient accumulation occurred between mid-May and November and between April and July. Little N, P, and K accumulated during the winter and early spring, however the accumulation patterns differed among the nutrients. The N and P accumulation patterns were similar to dry matter accumulation with about 50% of the total fruit N and P contents occurring mid-May and November and 50% occurring from April to July. In contrast, only about 30% of the total fruit potassium content occurred between mid-May and November, while 70% of the fruit K accumulated between April and July.

Fruit dry weights and nutrient contents were closely correlated (Figure 3). Best-fit trend lines indicated that fruit dry weight was linearly related to fruit N and P content and exponentially related to fruit K. These data indicate that fruit dry weight can be used to estimate N, P, and K fruit content in well fertilized orchards. The differences in the nutrient accumulation patterns may reflect the various roles these nutrients play in the fruit. Unlike most fruits, cell division in avocado mesocarp tissue is not restricted to the first 30 days after anthesis, but continues during fruit development and even occurs in the mature fruit attached to the tree. Indeed, cell division is the major factor that increases fruit size in the latter phase of fruit development. Both N and P play important roles in cell division and thus are required in order for the fruits to grow. Potassium is required for the production and transport of plant sugars that increase the weight of fruit. Thus, the large influx of K into fruit may reflect the role it plays in sugar transport as fruit reach maturity.

Fruit accumulated the majority of their nutrients between full bloom and autumn and during the following spring. These periods of high fruit nutrient demand should coincide with fertilizer applications. Spring (April) fertilization with nitrogen over a four-year period, for example, increased yield by 50% over the control where nitrogen was metered out in six N applications over the year (Lovatt, 2001). These increases occurred despite the lack of evidence of N deficiency in leaves. April nitrogen fertilization appears to a critical to support fruit development of the current crop, fruit set for the next crop, and growth of the vegetative flushes.

In the coming years this project will incorporate fruit and whole tree nutrient data into a nutrient fertility model for avocado trees. We are currently evaluating tree fertilization models and seeking input from growers and researchers to improve the models to meet the needs of California avocado growers.

LITERATURE CITED

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Lovatt, C. J. 2001. Properly timed soil-applied nitrogen fertilizer increases yield and fruit size of 'Hass' avocado. Journal of the American Society for Horticultural Science, 126(5): 555-559.

ACKNOWLEDGEMENTS

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Figure 1.
Dry matter accumulation in avocado fruits over the season.

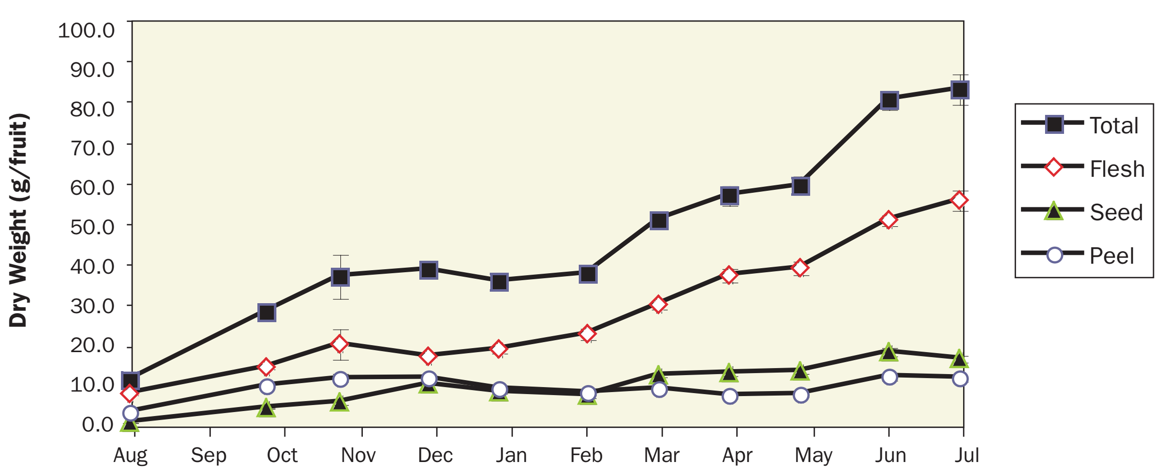

Figure 2.
Nitrogen, phosphorus, and potassium accumulation in avocado fruits over the season.

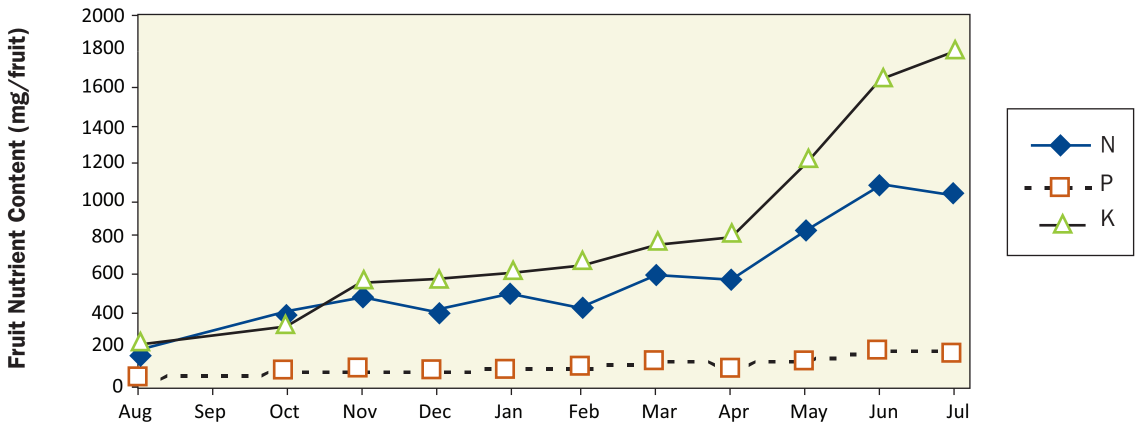

Figure 3.
Relationship between dry matter content and nitrogen, phosphorus, and potassium accumulation in avocado fruits over the season.