Increasing Yield of the 'Hass' Avocado by Adding P and K to Properly Timed Soil N Applications

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Statement of Objective: Results obtained from two previous CDFA-FREP funded research projects established that the time of N application to the soil was more important than the amount of N with regard to yield and fruit size of the 'Hass' avocado in California. Application of N in July and August (40 lbs. total N per acre per year) achieved an equal or greater total yield and yield of commercially valuable large size fruit (packing carton sizes 60+48+40, i.e., fruit weighing 178-325 g/fruit) for the 4 years of the study than multiple N treatments supplying 68% more N. The research was conducted in orchards with optimal nutrition based on standard leaf analysis and located in two climatically and edaphically different avocado-growing areas of California to determine whether strategies work across avocado-producing areas of the state. With identification of the proper time to apply N fertilizer, the next logical question was whether a greater response to N soil applications would be obtained if P and K were supplied simultaneously. Due to its immobility, P is commonly limiting. K runs a close second due to its high mobility and loss by leaching. In addition, avocado trees have a high demand for K because avocado fruit are rich in K, having more K/g fresh wt. edible fruit than bananas! This project tested the following hypothesis: low available soil P or K at key stages in tree phenology will diminish the tree's response to properly timed soil-applied N.

Project Objectives: The objectives of the research were: (1) to quantify the effects of properly timed soil-applied N vs. N supplemented with P and K on yield, fruit size and alternate bearing index in a commercial 'Hass' orchard with optimal nutrition based on leaf analysis, and (2) to disseminate the results of the research to the avocado growers of California.

Executive Summary: The fertilizer strategies significantly affected 3-year cumulative total yield as both kilograms ($P = 0.0035$) and number of fruit ($P = 0.0111$) per tree. Trees receiving 1x NPK in July and August produced a significantly greater 3-year cumulative total yield (in kilograms and number of fruit per tree) than trees

receiving 2x N in November, 2x NPK in November, 2x NPK in April and BMP NPK. All other treatments resulted in intermediate 3-year cumulative total yields that were not significantly different from any other treatment. Trees receiving 1x NPK in July and August and 2x N in April had significantly higher yields of commercially valuable large size fruit in the combined pool of packing carton sizes 60+48+40 as both kilograms (P = 0.0109) and number of fruit (P = 0.0105) per tree than trees receiving 2x NPK in November and BMP NPK. Yields for all other treatments were intermediate and not significantly different from any other treatment. In comparison to trees receiving only 1x N in July and August, supplementing N in this treatment with P and K had a consistent beneficial, though not statistically significant, effect on total yield and yield of commercially valuable large size fruit (combined pool of packing carton sizes 60+48+40; fruit weighing 178-325 g/fruit). Trees treated with 1x NPK in July and August produced total yields and yields of large size fruit (178-325 g/fruit) equal to or greater than trees receiving all other treatments, including the BMP N (control) or BMP NPK treatments. Note that trees receiving 1x NPK in July and August received 50% less N than trees in all other treatments and 50% less N P K than the other NPK treatments.

By September 2006, leaf analyses revealed that the BMP N (control) treatment had the highest leaf N concentration and trees receiving 1x N in July and August the lowest. Trees receiving BMP NPK or 1x NPK in July and August had leaf N concentrations that were significantly lower than the BMP N (control) but intermediate to and not significantly different from any other treatment. Leaf P concentration was not affected by fertilization. Trees receiving 1x NPK in July and August had the highest leaf K concentration, which was higher than all other treatments except BMP NPK and 2x NPK in April. Leaf NPK concentrations for trees in all treatments were in the middle to upper end of the optimal range. Despite receiving 50% less N or NPK, trees receiving 1x N or 1x NPK in July and August had increased leaf N or NPK concentrations, respectively, at the end of year 3.

Averaged over the 3 years of the experiment, fertilizer treatment had a significant effect only on the fruit quality parameter vascularization, the presence of vascular bundles and associated fibers in the flesh (P = 0.0405). The lowest amount of vascularization was in fruit from trees receiving 1x NPK in July and August and 2x NPK in April.

Conclusion: The results of this study confirmed that application of N in July and August at a significantly reduced rate (40-50 lbs. N/acre compared to 125-150 lbs. N/acre) results in total yields and yields of commercially valuable large size fruit that were equal to or greater than strategies with more frequent N applications supplying 50% to 68% more N fertilizer annually. July and August correspond to the following phenological and physiological events: July – period of "June" drop for the current crop (Garner, 2004), rapid N and K uptake by mature fruit from the previous spring bloom (Rosecrance and Lovatt, unpublished data), and development of the summer vegetative flush (Salazar-García et al., 1998) and August – period of exponential increase in fruit size for the current crop and abscission of mature fruit (Garner, 2004) and inflorescence initiation for next year's crop (Salazar-García et al., 1998). Supplying 1x NPK in July and August had a consistent beneficial, though not significant, effect on total yield and yield of

commercially valuable large size fruit (combined pool of packing carton sizes 60+48+40; fruit weighing 178-325 g/fruit) compared to trees receiving only N in July and August, and resulted in total yields and yields of large size fruit (178-325 g/fruit) equal to or greater than trees receiving 50% more N or NPK, including the BMP N (control) or BMP NPK treatment. Based on 7 years of yield data for 1x N in July and August and 3 years for 1x NPK in July and August, these fertilization strategies are cost-effective in sustaining high total yields and yields of large size fruit while protecting the environment and recommended for use with regular monitoring by leaf analysis.