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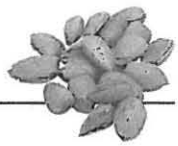

INCREASING YIELD OF THE 'HASS' AVOCADO BY ADDING P AND K TO PROPERLY TIMED SOIL N APPLICATIONS

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INTRODUCTION

'Hass' avocado yields in California have averaged only 5,700 lbs./acre for the last 25 years. Experimentally determined leaf nutrient standards and replacement fertilization data related to yield and fruit size are generally lacking for the 'Hass' avocado in California. Lovatt (2001) tested the hypothesis: Applying N to the soil at key stages of tree phenology will improve yield parameters. A four-year study (Lovatt, 2001) identified key stages in the phenology of the 'Hass' avocado that benefited from a double dose (2x) N (50 lbs./acre). The optimal application times for extra N corresponded to the following phenological events: 1) April – anthesis, fruit set, and initiation of the spring vegetative flush; and 2) November – end of the fall vegetative flush and beginning of flower initiation. At these phenological stages soil-applied 2x N significantly increased the four-year average yield and the four-year cumulative yield, and increased by 70% yield of commercially valuable large size fruit. In addition, the April application significantly reduced the alternate bearing index for the four years of the study.

In our similar, recently completed CDFA/FREP-funded project on optimal timing of N fertilization, treatments producing the three numerically, but not statistically, greater cumulative yields for 2001 plus 2002, were the soil application of 3x N in April > the control > application of 2x N in November. In this study, each of the optimal times for applying N was incorporated into the control as a single dose of N (1x N, 25 lbs. N/acre). The optimal times were: 1) April – anthesis, fruit set and initiation of the spring vegetative flush; 2) July – rapid increase in fruit size; 3) August – transition from vegetative to reproductive development, i.e., inflorescence initiation; and 4) November – end of the fall vegetative flush and beginning of flower initiation. No treatment significantly affected potential nitrate pollution of groundwater, but the control treatment did reduce its potential by a large numerical value.

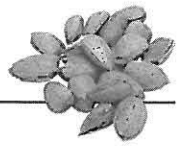
These two research projects were conducted in orchards with optimal nutrition based on standard leaf analysis. Moreover, the orchards were located in two climatically and edaphically different avocado growing areas of California to develop a strategy that works across avocado-producing areas of California. With the identification of the proper time to apply N, the next logical question is 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 tests the 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.

OBJECTIVES

The objectives of the research are: 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) disseminate the results of the research to the avocado growers of California. Treatments will continue for three years in order to obtain the year two harvests.

DESCRIPTION

To meet the first objective two fertilizer treatments (N or NPK) were applied at the following times: A) July and August; B) November; C) April; and D) July, August, November, and April (BMP for N, control). These



application times correspond to the following key stages of 'Hass' avocado tree phenology: July – period of rapid cell division and significant increase in fruit size, August – inflorescence initiation; November – end of the fall vegetative flush and beginning of flower initiation; and April – anthesis, fruit set and initiation of the spring vegetative flush. The treatments were replicated on 20 individual trees in a randomized complete block design. N was applied as ammonium nitrate to all treatments as follows: in treatment A, trees received only 50 lbs. N/acre/year, half in July and half in August according to the grower's standard practice. Treatments B and C received 50 lbs. N/acre in November and April, respectively, with the remaining 50 lbs. N/acre applied equally in April, July and August or July, August and November, respectively. Treatment D received 25 lbs. N/acre in July, August, November, and April. Thus, all treatments received 100 lbs./acre/year, except treatment A. The N treatments had been in effect for four years prior to the addition of P and K to half of the trees in each treatment (20 trees per treatment) in year 1 of this project. The rates of P and K were 15 and 90 lbs./acre, respectively, with trees receiving a double dose of P and K (7.5 and 45 lbs./acre, respectively) with the double dose of N only (treatment A) or the remaining P and K with the remaining N (treatments b and C). Trees in BMP for NPK treatment received 3.75 lbs. P and 22.5 lbs. K in July, August, November, and April. The orchard is located in Somis, Calif. The trees are 24-year-old 'Hass' on Duke 7.

Harvest data include total kg fruit/tree. The weight of 100 randomly selected individual fruit/tree was used to calculate packout (fruit size distribution)/tree and total number of fruit/tree. Two fruit per tree were evaluated for the length of time to ripen, peel color at maturity, and internal fruit quality (seed germination, vascularization, discoloration, decay). Fruit quality parameters were visually determined using a scale from zero (none) to four (extensive, present in all four quarters of the fruit). All data were statistically analyzed using the General Linear Model procedures of SAS. ANOVA was used to test for treatment effects on yield, fruit size, and fruit quality parameters. Means were separated using Duncan's multiple range test at $P \leq 0.05$ and at $P \leq 0.10$. In year 3 when the second set of harvest data will be obtained, treatment effects on cumulative yield and on alternate bearing index [ABI = (year 1 yield – year 2 yield) ÷ (year 1 yield + year 2 yield)] will be determined by ANOVA. Treatment effects across years will be determined by repeated measures analysis with year as the repeated measures factor. A cost/benefit analysis for each treatment will be calculated.

RESULTS AND CONCLUSIONS

Trees receiving 1x NPK (25, 3.75 and 22.5 lbs. NPK/acre, respectively) in July, and again in August, yielded significantly more large size fruit (packing carton sizes 60+48+40, i.e., fruit weighing 178-325 g, and packing carton sizes ≥ 60, i.e., fruit weighing ≥ 173) per tree ($P \leq 0.10$) and had numerically, but not significantly, more total yield per tree compared to trees receiving only 1x N in July and August, trees in the BMP for NPK treatment, and trees receiving a double dose of NPK (2x NPK) in November (Table 1). Supplying P and K with N in the other treatments had no significant effect on total yield or yield of large size fruit at the end of the first year of the experiment.

Table 1 Effect of N, P and K fertilization strategies on the yield of 'Hass' avocado harvested after one year.

	Yield (kg/tree)	
Treatment	Total	☒60+48+40 (178-325 g)
1x NPK in July + Aug.	71.7	47.1 az
BMP N (Control) (1x N in July, Aug., Nov. + April	61.5	40.3 ab
2x N in April	51.6	32.3 ab
2x NPK in April	45.0	31.7 ab
2x N in November	41.5	31.4 ab
1x N in July + Aug.	43.4	29.6 b
BMP NPK (1x NPK in July, Aug., Nov. + April	40.3	28.5 b
2x NPK in November	41.6	26.3 b
P-value	0.1134	0.0944

Values in a vertical column followed by different letters are significantly different at the specified P level by Duncan's Multiple Range Test.

Fertilization treatments had no effect on the length of time it took for fruit to ripen after harvest, peel color at maturity, seed size, seed germination at maturity, or vascularization or discoloration of the mature fruit flesh. The trees receiving a double dose of NPK in November had significantly more internal flesh decay, especially at the stem end, than all other treatments except fruit from trees in the BMP NPK treatment ($P \leq 0.10$).

Alternate bearing is a characteristic of the 'Hass' avocado. Thus, additional years of yield data are required before any conclusions can be made.