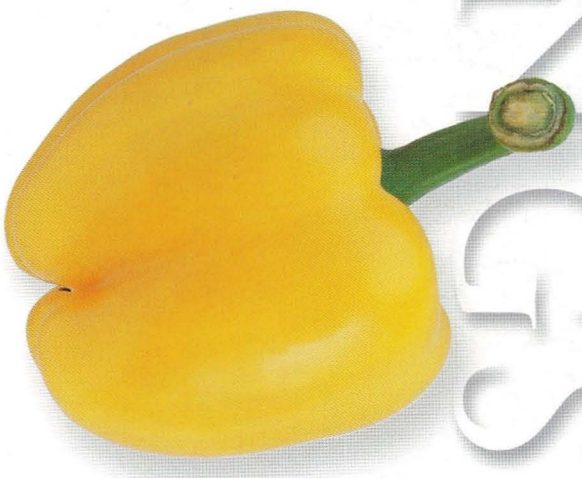
FERTILIZER RESEARCH AND EDUCATION PROGRAM CONFERENCE

PROCEEDINGS



NOVEMBER 14, 2001

TULARE, CA

CDFA™

California Department of Food and Agriculture

Development of Nitrogen Best Management Practices for the 'Hass' Avocado

Project Leader:
Carol J. Lovatt
Department of Botony and Plant Sciences
University of California
Riverside, CA 92521-0124
(909) 787-4663
carol.lovatt@ucr.edu

Cooperator:
John Grether
Grether Farming Company, Inc.
4049 Walnut Avenue
Somis, CA 93066

OBJECTIVES

1. Quantify the nitrate pollution potential of the various nitrogen fertilization strategies.
2. Identify the threshold rate of nitrogen fertilization above which the pollution potential increases.
3. Evaluate the potential for replacing the April double dose or triple dose of soil nitrogen with foliar nitrogen.
4. Provide a ratio of enhanced-yield benefit to environmental cost for each nitrogen fertilization strategy.
5. Identify BMP's for nitrogen fertilization for the 'Hass' avocado in California.

DESCRIPTION

To protect the groundwater from potential nitrate pollution, 'Hass' avocado growers in California divide the total annual amount of nitrogen (56-168 kg.ha^{-1}) into six small soil applications made during the period from late January to early November. The lack of research data raised the question of whether 'Hass' avocado yield was being compromised by this fertilization practice. In a previous study, Lovatt (2001) addressed the question of whether yield of 'Hass' avocado could be increased by doubling the amount of N currently applied during specific stages of tree phenology. The control in this experiment was the practice of annually applying N as NH_4NO_3 at 168 kg.ha^{-1} (168 trees/ha) in six small doses of N at 28 kg.ha^{-1} in January, February, April, June, July, and November. From these six application times, five were selected on the basis of tree phenology and additional N as NH_4NO_3 at 28 kg.ha^{-1} was applied at each time for total annual N of 196 kg.ha^{-1}. Two phenological stages were identified for which N application at 56 kg.ha^{-1} in a single application (double dose of N) significantly increased the 4-year cumulative yield (kilograms fruit per tree) 30% and 39%, respectively, compared to control trees ($P \leq 0.01$). In each case, more than 70% of the net increase in yield was commercially valuable large size fruit (178-325 g/fruit). The two phenological stages were: when shoot apical buds have four or more secondary axis inflorescence meristems present (mid-November); anthesis-early fruit set and initiation of the vegetative shoot flush at the apex of indeterminate floral shoots (approx. mid-April). When the double dose of N was applied at either of these two stages, the kilograms and number of large size fruit averaged across the 4 years of the study was significantly greater than the control trees ($P \leq 0.01$). Averaged across the 4 years of the study, only the November treatment increased yield compared to the control trees ($P \leq 0.05$). Application of the double dose of N at flower initiation (January), during early-stage gynoecium development (February), or during June drop had no significant effect on average or cumulative yield or fruit size compared to control trees. Application of the double dose of N in April significantly reduced the severity of alternate bearing ($P \leq 0.05$). Yield was not significantly correlated with leaf N concentration. Time and rate of N application are factors that can be optimized to increase yield, fruit size, and annual cropping of 'Hass' avocado. When the amounts of N applied were equal (196 kg.ha^{-1}), time of application was the more important factor. You may receive a copy of this paper by e-mailing your request to me at <carol.lovatt@ucr.edu>.

To determine whether the results obtained in the previous study, which was conducted in Temecula, could also be obtained with a different soil type and location, this research, including objectives not covered in the first experiment, is being repeated in a new orchard in Somis, representing the soils and climate of the northern avocado growing area. The new study also includes additional application times based on the discovery by my lab. that avocado trees transition from vegetative to reproductive growth at the end of July-

Table 1. Effect of nine nitrogen fertilization strategies applied April 1997 to January 1999[y] on the yield of 'Hass' avocado harvested in 1998 and 1999. The applications were made for an "on" year.[z]

Treatment[x]	*1997-99 total lbs. N/acre*	*1997-98 lbs. fruit/ tree*	*1998-99 lbs. fruit/ tree*
2x N in August (all years)	40.0	73.6 a[z]	37.8
Grower fertilization practice	42.5	70.7 a	40.1
2x N in November (prior to "on" years) and April ("off" years)	40.0	68.1 a	40.5
2x N in November (all years)	40.0	62.3 ab	44.6
Control	80.0	58.8 ab	49.4
2x N in April and November (no N in February and June) (all years)	80.0	58.8 ab	32.8
2x N in April ("off" years) and 3x N ("on" years)	60.0	58.6 ab	48.5
2x N in April (all years)	40.0	56.8 ab	42.1
2x N in April ("off years) and 3x N ("on" years) applied foliarly	100.0	42.3 b	44.6
P-value		0.06	NS

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

[y]Grower's fertilization practice is 40 lbs. N as ammonium nitrate/acre split as two applications in July and in August for all years of the experiment.

[x]The time of treatment applications is based on the following phenological events: 1) April – anthesis, fruit set and initiation of the spring vegetative flush; 2) August – inflorescence initiation; 3) November – end of the fall vegetative flush and beginning of flower initiation.

beginning of August (Salazar-Garcia et al., 1998). The research also integrates the results of a previous 2-year long study we undertook with funding from the CDFA FREP program. The results of this CDFA project provided evidence that foliar N fertilization was successful in increasing yield when urea was applied at the time the leaves of the new flush were 66% to 100% fully expanded but not hardened. So our current project includes both irrigation and foliar ap-

Table 2. Effect of nine nitrogen fertilization strategies initiated in January 1999[y] on the average number of inflorescences per sylleptic shoot in spring 2000 and on yield of 'Hass' avocado harvested in 2001. The applications were made for an "on" year.[z]

Treatment[x]	*2000-2001 lbs. fruit/ tree*	*Average number of inflorescences per shoot*
2x N in August (all years)	179 ab	2.20 c
Grower fertilization practice	181 ab	4.36 abc
2x N in November (prior to "on" years) and April ("off" years)	201 a	4.68 abc
2x N in November (all years)	202 a	3.16 bc
Control	169 ab	3.85 abc
2x N in April and November (no N in February and June) (all years)	178 ab	4.50 abc
2x N in April ("off" years) and 3x N ("on" years)	199 a	5.25 ab
2x N in April (all years)	209 a	3.65 abc
2x N in April ("off years) and 3x N ("on" years) applied foliarly	150 b	6.15 a
P-value	0.10	0.06

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

[y]Grower's fertilization practice is 40 lbs. N as ammonium nitrate/acre split as two applications in July and in August for all years of the experiment. Since January 1999 control trees received 125 lbs. N as ammonium nitrate/acre, divided into five, 25 lbs./acre applications made in mid-January, mid-April, mid-July, mid-August, and mid-November. Trees in all other treatments received 125 lbs. N/acre applied as 2N=40lbs./acre or 3N=60lbs./acre in the months indicated. The total N applied in any treatment is 125 lbs./acre; the amount of N applied in other months is reduced to compensate for the extra N applied in the month(s) specified for the treatment.

[x]The time of treatment applications is based on the following phenological events: 1) April – anthesis, fruit set and initiation of the spring vegetative flush; 2) August – inflorescence initiation; 3) November – end of the fall vegetative flush and beginning of flower initiation.

plied nitrogen applications. Foliar applications are made to simulate helicopter application. We are also testing different nitrogen fertilization strategies that are designed specifically for "on" and "off" years to even out alternate bearing and increase cumulative yield. To understand the mechanism by which nitrogen fertilization influences alternate bearing, we are quantifying the effect of the nitrogen treatments on the quantity of sylleptic and proleptic shoots produced, the growth of each shoot type and the productivity of each shoot type. Basic information about the relative productivity of sylleptic vs. proleptic shoots is not only important for optimizing fertilization but is also fundamental to pruning practices. Our prior research was the first to consider tree phenology and crop load in the fertilization of the 'Hass' avocado and our current project is the first to use nitrogen fertilization as a tool to control alternate bearing.

RESULTS AND CONCLUSIONS

The results of the first harvest (1997-98) clearly demonstrated that the time of N fertilizer application is more important than the amount of N that was applied (Table 1). However, the rates of N applied that year were incorrect (Table 1). The error was corrected starting in January 1999. Henceforth, all treatments received 125 lbs. N/acre. Yields for the subsequent 1998-99 and 1999-2000 harvests were compromised by the freeze of December 1998. N treatments had a significant effect on both the number of inflorescences produced and the fruit set on sylleptic shoots tagged January 2000 and 2001 (Table 2). Time of N application had a significant effect on yield for the harvest of 2000-01 (Table 2). The best treatments were all due to extra N applied to the soil in November or April. These results are consistent with the results of our earlier research conducted in Temecula. Foliar application of urea in April was not effective. Harvest data for additional years is needed to confirm the results obtained in 2001.

Literature Cited

Lovatt, C.J. 2001. Properly timed soil-applied nitrogen fertilizer increases yield and fruit size of 'Hass' avocado. J. Amer. Soc. Hort. Sci. 126:555-559.

Salazar-Garcia, S., E.M. Lord, and C.J. Lovatt. 1998. Inflorescence and flower development of the 'Hass' avocado (*Persea americana* Mill.) during "on" and "off" crop years. J. Amer. Soc. Hort. Sci. 123:537-544.