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NITROGEN FERTILIZATION OF THE HASS AVOCADO

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The first clear evidence on the effects of nitrogen fertilization on yields of avocado was developed for the Fuerte variety (2). This report showed that maximum production was associated with nitrogen concentrations in spring-cycle leaves sampled in the mid-August to mid-October period ranging from 1.6 to 2.0 per cent. Rates of nitrogen which resulted in concentrations of nitrogen in leaves that were above or below this range were associated with reductions in yield. A subsequent experiment (1) confirmed the deficient range of N for the Fuerte and showed that the rate of nitrogen required to obtain leaf nitrogen in the most productive range was considerably higher than in the previous experiment. In the latter experiment four pounds of nitrogen per tree did not result in leaf nitrogen values above 1.8 per cent.

Experiments show that the Fuerte avocado leaf nitrogen-yield curve (2) is applicable for the MacArthur variety in the range of 1.2 to 1.8 per cent nitrogen in the leaves (3). Values above 2.0 per cent nitrogen in MacArthur leaves were not obtained experimentally, even with rates as high as five pounds of nitrogen per tree annually.

One experiment with the Jalna variety (1) indicated that it was difficult to obtain leaf values above 2.0 per cent nitrogen. Two- and four-pound rates of nitrogen resulted in leaf values of about 2.0 per cent nitrogen while withholding of nitrogen resulted in leaf values between 1.6 and 1.7 and in a reduction in yield.

The present report summarizes results from two nitrogen fertilizer experiments on the Hass variety.

EXPERIMENTAL ORCHARDS AND PROCEDURES

Fallbrook experiment: This experiment, near Fallbrook, was conducted on mature Hass trees situated on a Vista sandy loam. The orchard was nontilled and sprinkler irrigated. What little volunteer grass that grew under the rather shady conditions was mowed.

There were four rates of nitrogen arranged in a 4 x 4 Latin square with four trees per plot. Thus, there were four replications of four-tree plots for each nitrogen rate. Each plot was surrounded by border trees. Ammonium nitrate was applied in the January- to March-period each year, according to the rates indicated in Table 1. Spring-cycle leaves were sampled in the mid-August to mid-October period.

TABLE 1. Rates of nitrogen in the Fallbrook and Ventura Hass avocado experiments.

	Pounds nitrogen per tree annually				
Nitrogen	*Fallbrook experiment*			*Ventura experiment*	
rate	1956	1957-58	1959-60	1960-61	1962-66
1	0	0	½	¼	½
2	½	¾	1	½	1
3	1	1½	2	1	2
4	2	3	4	2	4

Ventura experiment: This experiment, near Ventura, was conducted on mature Hass trees situated on Yolo soil. The orchard was nontilled, sprinkler irrigated, free of weeds and volunteer ground cover.

There were four rates of nitrogen in factorial combination with four timing treatments, for a total of sixteen treatments which were replicated eight times. Ammonium nitrate was used according to the rates outlined in Table 1. The four times of application were: February, July, November, and an application split between February and November. Spring-cycle leaves were sampled in the mid-August to mid-October period.

Results

Fallbrook experiment: Results from this experiment, which appear in Table 2, are for the last four years of the experiment—a period in which maximum effectiveness of the differential treatments could be observed. Although treatment induced significant differences in the concentrations of nitrogen in the leaves, there was no significant effect on yield in any year. Although the high rate of nitrogen resulted in a mean nitrogen concentration of 2.20 per cent in 1957 and 2.14 in 1959, there was no indication of a yield reduction at these levels. Similar levels in the Fuerte variety could have resulted in a reduction in yield (2).

TABLE 2. Effect of nitrogen rate on yield and nitrogen concentration in leaves—Hass avocado, Fallbrook.

Nitrogen rate	Yield, pounds/tree, mean 1958-61	Per cent nitrogen in dry leaves August-October period				
		1958	1958	1959	1960	mean 1957-60
1	207	1.76	a	1.72	1.73	1.74
2	188	1.79	a	1.80	1.83	1.81
3	217	1.91	a	1.95	1.95	1.94
4	223	2.18	a	2.14	2.02	2.12
Significance b	NS	***		***	***	***

a—Avocado brown mite injury to leaves—no sample obtained.
b—NS indicates not statistically significant.
***—significant at the 0.1% level.

Ventura experiment: Although factors other than nitrogen appeared to be limiting yields in this experiment, the highest rate of nitrogen did result in yields significantly higher than those associated with the three lower rates (Table 3). After the rates of nitrogen were increased up to four pounds per tree anually in 1962, the concentrations of nitrogen were rather uniformly associated with treatment for three years, but in 1965 the concentrations in all treatments dropped (Table 4).

TABLE 3. Effects of nitrogen rate on yield—Hass avocado, Ventura.

Nitrogen rate	Yield — pounds per tree						mean
	1961	1962	1963	1964	1965	1966	1961-66
1	62	109	22y *a*	99	29yz *a*	36y *a*	60y
2	87	109	25y	102	25y	48y	66y
3	65	114	35yz	96	24y	45y	63y
4	53	148	67z	110	48z	103z	88z
Significance b	NS	NS	***	NS	**	***	***
C.V. c	91	69	127	89	94	81	104

a—Differences are significant at the 1% level if there are no subscript letters in common.
b—NS indicates not statistically significant.
**—significant at 1% level.
***—significant at the 0.1% level.
c—C.V. is the coefficient of variability obtained by dividing the square root of the error variance by the grand mean and multiplying by 100.

TABLE 4. Effect of nitrogen rate on the concentration of nitrogen in leaves — Hass avocado, Ventura.

Nitrogen rate	Percent nitrogen in dry leaves, September-October period						
	1960	1961	1962	1963	1964	1965	Mean 1960-65
1	1.79	1.74	2.08	2.06	2.12	1.87	1.94
2	1.86	1.76	2.15	2.10	2.18	1.92	2.00
3	1.90	1.84	2.26	2.22	2.23	1.95	2.07
4	1.98	1.91	2.30	2.32	2.31	2.00	2.13
Significance *a*	***	***	***	***	***	***	***
C.V. b	8	7	7	6	6	6	11

a ***—significant at the 0.1% level.

b C.V. is the coefficient of variability obtained by dividing the square root of the error variance by the grand mean and multiplying by 100.

Timing of application of nitrogen had no significant effect on yield. Also, there was no significant interaction between rates and timing of nitrogen on yield. This means that rates of nitrogen responded similarly in all timing treatments. Therefore, the yield data for timing are not presented.

Discussion

From the limited experimental evidence now at hand on nitrogen fertilization of the Hass avocado, two points appear to be of practical significance. The first is that yields of the Hass variety appear to be less sensitive to variations in nitrogen nutrition than yields of Fuerte. The second point is that there is, as yet, no evidence that a high level of nitrogen nutrition will reduce yields of the Hass as it did with the Fuerte variety (2). On the contrary, in the Ventura experiment the highest rate of nitrogen did result in an increase in yield.

It is possible that in the Ventura experiment observed results may have been due to some indirect influence of differential nitrogen fertilization. If nitrogen was the primary influential factor in the two experiments reported here, one would expect a stepwise increase in yield as the rates increased, with the greatest increase occurring between nitrogen rates one and two.

Regardless of the explanation of the observed results, the fact that no adverse effects were observed at the highest rates of nitrogen, and beneficial effects resulted from the highest rate in one experiment, suggests that the Hass variety should be maintained at a higher level of nitrogen than the Fuerte.

Although on optimum level of leaf nitrogen cannot be determined from the experimental evidence at hand, the evidence suggests that the nitrogen concentration in spring-cycle leaves sampled in the mid-August to mid-October period should not be less than 2.0 per cent.

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