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Effect of Fertilization, Ringing, Blossoming and Fruiting on the Nitrogen Content of Avocado Leaves

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An extension of the investigation on the irregular fruiting behavior of the Fuerte variety of avocado in southern California[1] has involved studies of the effect of fertilization, ringing, blossoming and fruit removal on the nitrogen content of mature avocado leaves. We realize that conclusions based on data obtained from leaf analyses alone are not very convincing. However, it was not possible to analyze whole trees or even large branches. Therefore, the leaves, which constitute about twenty per cent of the total fresh or dry weight of the tree, were selected as affording the simplest criterion of changes in composition of the tree as a whole. More comprehensive studies involving whole trees dug at three-weekly-intervals throughout a period of a year are now in progress.

Leaf collections were made periodically between October, 1934 and July, 1937. The frequency of collection varied from about two days for the study of the effect of blossoming to several months for the determinations of the effect of fertilization. Material for analysis was obtained from an outstanding orchard in the La Habra Heights district and from the orchard on the campus of the University of California at Los Angeles. The number of leaves per sample varied from 50 to 300. It is believed that the samples were representative of the leaves on the tree or branch at the time of collection. After collection the leaves were wiped free from dust with a dry cloth, dried, ground and analyzed for nitrogen content by the Kjeldahl-Gunning method. All the collections at La Habra and most of those at Los Angeles involved only the Fuerte variety. Nabal was included in some of the collections at Los Angeles. The data for the two varieties are so similar that only those relating to Fuerte are presented in the tables and graphs.

[1]Hodgson, R. W. and Cameron, S. H., "Studies on the Bearing Behavior of the Fuerte Avocado Variety," Yearbook, California Avocado Assn., 1935, pp. 156-165.
Hodgson, R. W. and Cameron, S. H., "Temperature in Relation to the Alternate Bearing Behavior of the Fuerte Avocado Variety," Proc. Am. Soc. Hort. Sci. 33: 55-60. 1936.

EFFECT OF FERTILIZATION

In the orchard at La Habra an attempt has been made to determine the effect on bearing behavior of increasing and decreasing the nitrogen supply of the tree. This orchard had been well fertilized for several years prior to the initiation of our trials; tree appearance and behavior suggested an adequate supply of nitrogen. Pairs of trees in the same crop phase were selected—one for the test, the other as a control. Applications of ten pounds of nitrogen per tree per year in the form of ammonium sulfate

and calcium nitrate were made in the autumn of 1933, 1934 and 1935 to certain of the test trees, and to others 200 pounds of cereal straw per year. Soil samples taken at intervals subsequent to the applications medicated an excess of nitrate nitrogen in the soil surrounding the fertilized trees and none, or only a trace, beneath the "straw" trees.

TABLE 1

Effect of Fertilization on the Nitrogen Content of Avocado Leaves

Date of Collection	Treatment	Number of Leaves	Total Dry Weight	Nitrogen on Dry Weight	Nitrogen Per Leaf
			gms.	per cent	mgm.
1934 October 10	Control	75	.85	1.94	16.5
	Straw	110	.78	2.18	17.0
	Am. Sulfate	64	.73	2.11	15.4
November 30	Control	306	.77	2.18	16.8
	Straw	329	.83	2.30	19.1
	Am. Sulfate	353	.80	2.43	19.5
1935 February 1	Control	290	1.22	2.18	26.6
	Straw	300	1.17	2.27	26.6
	Am. Sulfate	300	.....	2.26	.....
April 19	Control	253	1.12	1.88	21.0
	Straw	272	1.15	2.02	23.2
	Am. Sulfate	219	1.17	1.95	22.8
November 1	Control	328	.96	2.05	19.7
	Straw	325	.97	2.12	20.6
	Am. Sulfate	326	1.02	2.04	20.8
1936 January 15	Control	307	1.04	1.87	19.5
	Straw	.....	.....	1.99	.....
	Am. Sulfate	300	1.04	2.03	21.1
April 15	Control	307	.96	1.72	16.5
	Straw	325	.91	1.70	15.5
	Am. Sulfate	323	.98	1.83	17.9

Collections of 100 to 300 leaves have been made from these trees as indicated in Table 1. At no time has the nitrogen content of the leaves from fertilized or "straw" trees been consistently or significantly above or below that of the controls. As yet no differences in appearance, bearing behavior or size of crop have been observed. Probably if these trials are continued for several more years, differences will become evident.

EFFECT OF BLOSSOMING AND LEAF FALL

The Fuerte avocado tree characteristically blossoms profusely for a period of from four to six months. During at least half of that period a large tree may carry continuously from 50 to 60 pounds of blossoms containing about three pounds of nitrogen.

Between March 9 and June 3, 1937, samples of 50 leaves were collected at from two to four day intervals from Fuerte and Nabal trees in the orchard at Los Angeles. In Figure 1 a gradual reduction in nitrogen content of the leaves during blossoming is indicated. Presumably this is due to a withdrawal of nitrogen from the leaves and its utilization elsewhere in the tree—probably the blossoms. The fact that during this period changes in dry weight parallel those in nitrogen content suggests that the reduction in nitrogen content is real and not apparent. All Fuerte trees shed many leaves during the spring. Those which blossom very profusely shed most of their leaves toward the end of the

blossoming period. Leaves which are about to fall lose their characteristic bright green color; becoming first light green, then yellow and finally brown. This transition, which requires only a few days, is associated with a very rapid reduction in dry matter and nitrogen content. The apparent reduction in nitrogen content frequently amounts to from 40 to 50 per cent of the total amount present in the normal leaf when calculated as a percentage of the dry weight. However, if the corresponding decrease in dry matter of 25 to 30 per cent is taken into account, the actual reduction in nitrogen amounts to more than 60 per cent of the total. These changes are illustrated by the data presented in Table 2. The data apply specifically to the trees at Los Angeles. However, similar material collected at La Habra gave almost identical results.

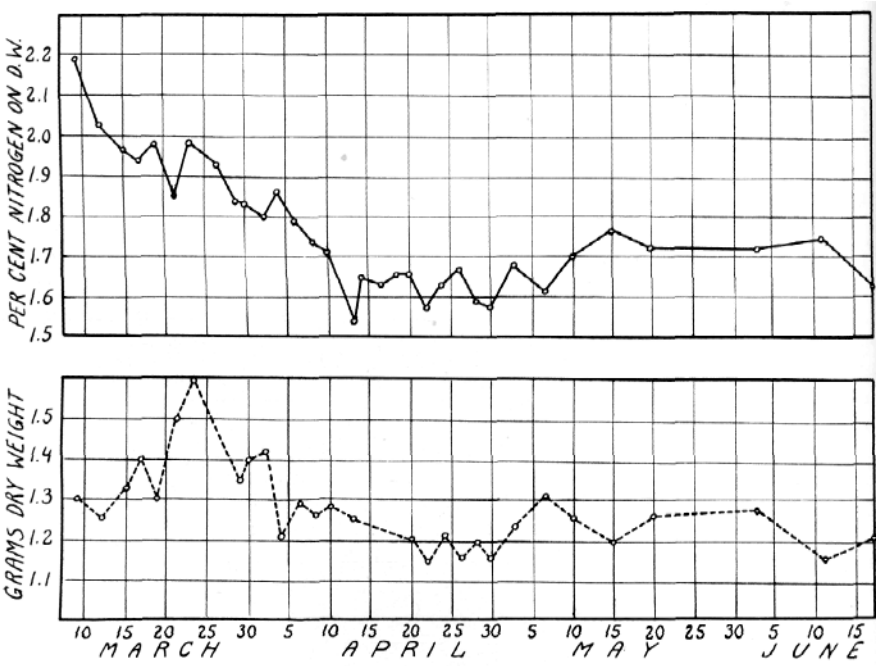


Fig. 1. Fluctuations in nitrogen and dry matter content of Fuerte avocado leaves during the blossoming period.

TABLE 2

Effect of Senility on Nitrogen Content and Dry Matter of Fuerte Avocado Leaves

Date of Collection	Condition of Leaf	Number of Leaves	Dry Weight per Leaf	Nitrogen on Dry Weight	Nitrogen per Leaf
			gms.	per cent	mgm.
1937 April 20	Control	52	1.21	1.66	20.0
	About to fall	46	.93	.86	8.0
May 3	Control	52	1.25	1.68	20.9
	About to fall	52	.92	.86	7.9
May 10	Control	52	1.26	1.70	21.5
	About to fall	52	.89	.92	8.2
May 15	Control	52	1.19	1.77	21.1
	About to fall	56	.86	.93	8.0
May 20	Control	52	1.26	1.73	21.8
	About to fall	50	.89	.96	8.5

EFFECT OF GIRDLING AND FRUIT REMOVAL

Girdling, which in this case consisted of the removal on November 1 of a ring of bark about one-quarter inch wide from branches about two inches in diameter, apparently resulted in a reduction in the nitrogen content of leaves on the branch above the girdle. Leaf collections were made at La Habra between four and seven months after the branches were ringed. As indicated in Table 3 fruit was harvested early (January 8) from some of the girdled and control branches and left until May 25 on others. When calculated as a percentage of the dry weight, a lower nitrogen content is indicated for leaves on girdled than for those on control branches (Tables 3 and 4). Leaves on girdled branches from which the fruit was removed appear to have a lower nitrogen content than those on which it was left. This reduction in nitrogen content is more apparent than real. Early removal—as soon as horticulturally mature—of a large crop from girdled as well as ungirdled branches almost invariably results in the leaves on that branch becoming paler in color than those on check branches. That this color change is associated with an increase in carbohydrate content is shown by the data in Table 3. Leaves on girdled branches from which the crop was harvested early contain more dry matter than leaves from similar branches on which the crop was left. The increase in dry matter accounts for an apparent decrease in nitrogen content when the latter is calculated as a percentage of the dry weight.

Table 3 illustrates the effects of girdling and crop removal on the nitrogen content of leaves of a tree which bore a very heavy crop in 1935-36 and which because of this heavy crop produced practically no bloom and set no crop in 1936 even on girdled branches from which the crop was removed early. A slight reduction in nitrogen content due to girdling is indicated.

TABLE 3

Effect of Girdling and Fruit Removal on the Nitrogen Content of Avocado Leaves

Date of Collection	Treatment	Number of Leaves	Dry Weight per Leaf	Nitrogen on Dry Weight	Nitrogen per Leaf
			gms.	per cent	mgm.
1936 March 10	Control fruit left	71	.91	2.08	18.9
	Control fruit removed	58	.89	2.04	18.2
	Girdled fruit left	61	.82	1.96	16.1
	Girdled fruit removed	60	1.14	1.57	17.9
April 3	Control fruit left	63	.77	1.94	14.9
	Control fruit removed	61	.72	2.10	15.1
	Girdled fruit left	67	.78	1.87	14.6
	Girdled fruit removed	66	1.05	1.43	15.0
May 12	Control fruit left	69	.84	1.75	14.7
	Control fruit removed	60	.85	1.71	14.5
	Girdled fruit left	60	.79	1.68	13.3
	Girdled fruit removed	59	1.00	1.38	13.8

Table 4 shows the effects on nitrogen content of girdling and fruit removal which was followed by profuse blossoming and heavy fruit set. In this case apparently because of the heavy blossoming there was a very marked reduction in nitrogen content of leaves on the girdled branches.

EFFECT OF FRUITING

Between July 3, 1935 and November 19, 1936 collections were made at intervals of about three weeks from the two adjacent trees at La Habra, both of which reversed crop phase during the period of collection. Figure 2 illustrates the fluctuations in nitrogen content of the leaves of these two trees. Throughout most of the year there are no significant differences; during the blossoming period the non-bearing tree appears to have a lower nitrogen content than the bearing tree. This difference we believe to be due to the relatively much heavier blossoming of the tree in the on-crop phase resulting in a heavier drain on the nitrogen content of the leaves and probably also of other parts of the tree.

TABLE 4

Effect of Girdling on the Nitrogen Content and Dry Weight of Avocado Leaves

Date of Collection	Treatment	Number of Leaves	Dry Weight per Leaf	Nitrogen on Dry Weight	Nitrogen per Leaf
			gms.	per cent	mgm.
1935	Control	16	.93	2.45	22.8
April 10	Girdled	16	.93	1.24	11.5
	Control	15	.85	2.20	18.7
	Girdled	15	1.09	1.22	13.3
April 26	Control	26	1.06	2.46	26.1
	Girdled	26	.95	1.38	13.1
	Control	26	.88	2.24	19.7
	Girdled	26	1.03	1.34	13.8
1936	Control	61	1.01	1.95	19.7
March 10	Girdled	61	1.15	1.65	19.0
April 3	Control	56	.94	1.86	17.5
	Girdled	57	.92	1.55	14.3
	Control	57	.96	2.00	19.2
	Girdled	50	1.15	1.70	19.5
May 12	Control	54	1.05	1.53	16.1
	Girdled	53	.88	1.30	11.5
	Control	53	1.03	1.77	18.2
	Girdled	45	.82	1.44	11.8

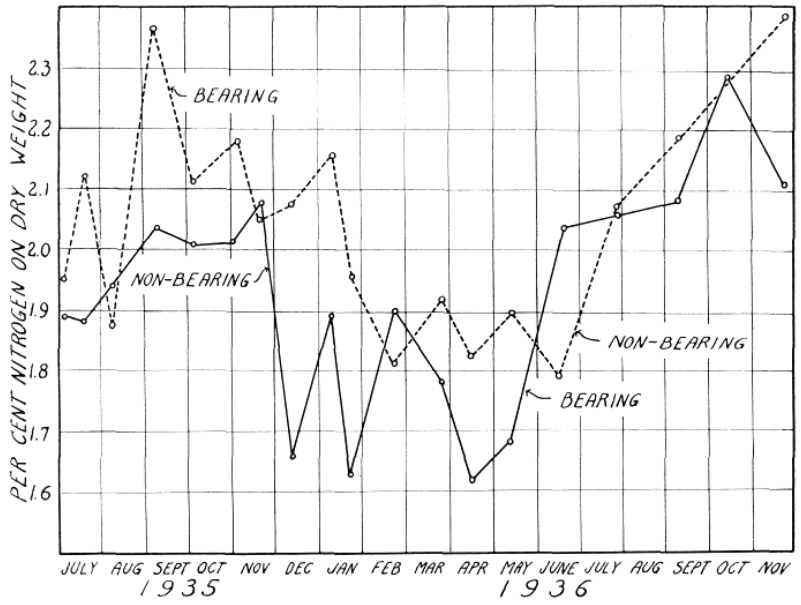


Fig. 2. Seasonal fluctuations in nitrogen content of leaves of bearing and non-bearing Fuerte avocado trees which reversed crop phase during the winter and spring of 1935-1936.

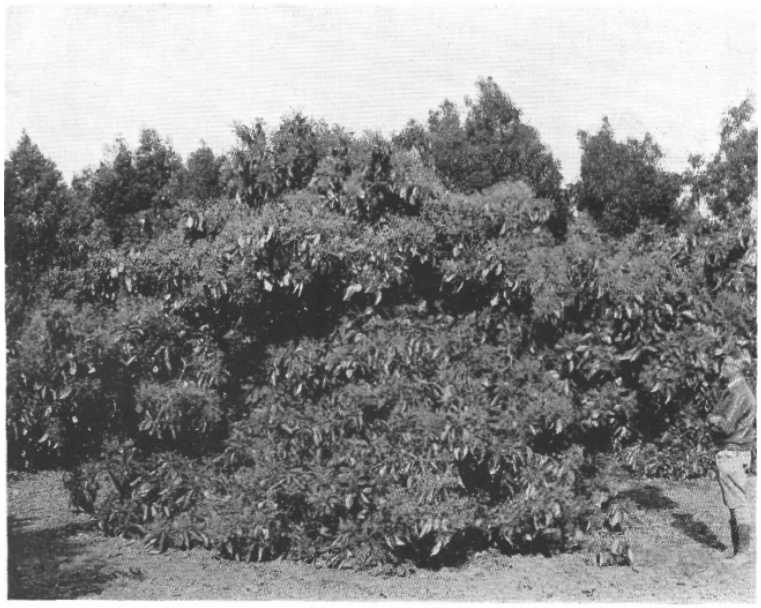
SUMMARY AND CONCLUSIONS

Based entirely upon observations of tree behavior and determinations of the nitrogen content of the leaves the following conclusions seem to be warranted:

1. In a well fertilized avocado orchard, practices designed to increase or decrease the nitrogen supply of the tree do not measurably affect the nitrogen content of the leaves within a period of three to four years.
2. Blossoming is accompanied by a reduction in the nitrogen content of adjacent leaves. There appears to be a direct correlation between amount of bloom and reduction in nitrogen content of leaves.

3. Girdling alone and in combination with early harvest results in a reduction in nitrogen content above the girdle due mainly to the fact that these treatments induce more profuse blossoming.
4. Presence or absence of fruit on a tree does not appear to directly influence the nitrogen content of the leaves.
5. Prior to abscission Fuerte and Nabal leaves lose approximately 60 per cent of their nitrogen.

Grateful acknowledgment is made for the cooperation of P. J. Weisel Inc., and Superintendent B. H. Marsh of La Habra Heights during the course of these studies.



. General view of the orchard in which the experiments were conducted.