California Avocado Society 1947 Yearbook 31: 51-54

Nitrogen Effects on Avocado Seedlings in Soil Cultures

A. R. C. Haas
University of California Citrus Experiment Station, Riverside, California

Although nitrogen is used in large quantities in the fertilization of avocado trees, very little information is available regarding the effect of the nitrogen from the standpoint of the vegetative phase of growth. Recently[1] it was reported that the vegetative growth of avocado seedlings grown under glasshouse conditions was at its best when a year's supply of nitrogen was divided into several applications rather than when all of the nitrogen was applied at one time.

In the present study ten 12-gallon crocks provided with drainage were filled with screened pasture soil (Hanford loam) obtained at the Citrus Experiment Station. Two seeds with their seed coats removed, were planted in the soil of each container in July, 1942, and later one of the plants in each culture was discarded. These containers were covered with wooden lids and placed out-of-doors. However, the wind, rain, and intense sunlight made it desirable to repeat the set-up under glasshouse conditions where the various factors could be better controlled. These glasshouse tests were terminated on March 26, 1945. Every few days as the soil ceased draining, six liters of nutrient solution were again applied to the soil. This solution was essentially Hoagland's solution in which calcium nitrate and all other nitrogen sources were omitted, and in their stead were added various concentrations of nitrate in the form of calcium nitrate. Calcium sulfate solution was used to make the quantities of calcium added to each container similar in amount. All chemicals were of the best grade obtainable and distilled water was employed at all times. Dilute sulfuric acid was used in the regulation of pH to approximately pH5.

The parts per million of nitrate (NO_3) received by the soil cultures were: 25, 50, 75, 100, 125, 150, 250, 350, 450, and 550 (table 1). The growth of the avocado trees during the period of the experiment is indicated by measurements shown in table 1. At 100 to 150 p.p.m. nitrate (NO_3) concentration, the basal circumference of the trunks was largest, whereas at about 100 p.p.m. nitrate concentration the height of the trunk has reached its maximum. The fresh weight of the leaves was improved at 150 p.p.m. or more of nitrate, whereas at 100 p.p.m. nitrate concentration the fresh weight of the trunk and branches markedly increased and at the highest nitrate concentrations growth increments were still evident. The dry weights of the trunks and branches indicate that the range of nitrate concentration from 100 to 150 p.p.m. was associated with excellent growth. In the nitrate range employed, concentrations higher than 100 p.p.m. depressed the fresh weight of the roots. Each of the trees possessed tap roots except those in cultures numbers 27 and 28.

TABLE I

Growth of seedling avocado trees in glasshouse soil cultures with various maintained concentrations of nitrate nitrogen

Soil culture No.	NO_3 (nitrate) nitrogen in culture solution added to soil (p.p.m.)	Circumference of trunk (inches)	Height of trunk (inches)	Fresh weight of leaves (grams)	Fresh weight of trunk and branches (grams)	Dry weight of trunk and branches (grams)	Fresh weight of roots (grams)
19	25	3 6/16	70	211	479	248.6	667
20	50	3 15/16	80	383	592	284.4	878
21	75	3 8/16	91	380	593	265.5	1285
22	100	4 9/16	112	374	1022	468.7	1310
23	125	4 6/16	98	366	1062	504.0	840
24	150	4 14/16	94	428	1047	480.6	1052
25	250	3 15/16	110	390	916	378.3	565
26	350	3 14/16	103	569	911	342.9	819
27	450	3 9/16	114	533	1132	438.4	482
28	550	3 11/16	112	703	1212	469.0	435

Fig. 1 shows a comparable portion cut from the middle and across the midrib of an avocado leaf representative of each culture. In the leaf pieces from tree cultures numbers 23 and 24 (125 and 150 p.p.m. nitrate cultures) the change in the intensity of the green color (chlorophyll) becomes quite marked.

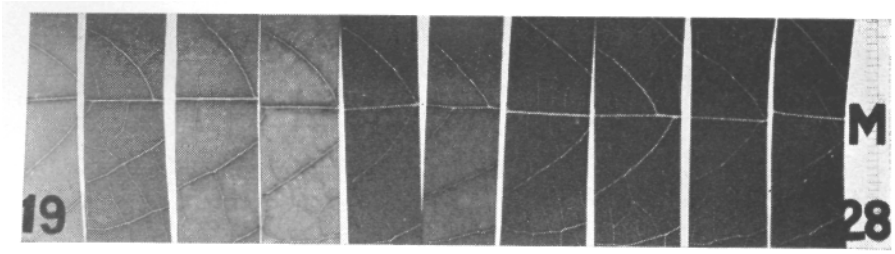

Fig. 1. Pieces of avocado leaves cut across the midrib (M) midway between the tip and base of the leaf blade. The photograph shows the intensity of the green color (chlorophyll) in the leaves at various (maintained) soil nitrate concentrations; increasing from left to right.

When the experiment was terminated, chemical analyses were made of the leaves, petioles, and rootlets. Table 2 shows no appreciable changes in the calcium, magnesium, and potassium content in the dry matter of the leaves when the calcium content of all the culture solutions was kept constant by the use of calcium sulfate (gypsum).

The total nitrogen in the dry matter of the petioles was determined by means of the micro Kjeldahl method and in table 2 it is seen that the total nitrogen content is greatest at the higher end of the range of nitrogen concentrations used in the culture solutions. Chemical analysis and physical appearance of the avocado leaves agree in one important manner:

(a) Cultures numbers 23 and 24 (nitrate range 125 to 150 p.p.m table 2) show the first real increase in total nitrogen in the dry matter of the petioles.

(b) Figure 1 likewise shows cultures numbers 23 and 24 (nitrate range 125 to 150 p.p.m.) as having leaves with the first real change in the intensity of their green color.

TABLE II

Composition of leaves, leaf stalks (petioles), and rootlets of avocado seedlings in soil cultures maintained at various nitrate nitrogen levels in the glasshouse

Culture no.	NO_3 (nitrate)* nitrogen in culture solution added to soil (p.p.m.)	In dry matter of leaves			Total nitrogen (N) in dry matter of leaf stalks (petioles) (per cent)	Total phosphorus (P) in dry matter of leaf stalks (petioles) (p.p.m.)	Total phosphorus (P) in dry matter of leaves (p.p.m.)	Total phosphorus (P) in dry matter of rootlets (p.p.m.)
		Calcium (per cent)	Magnesium (per cent)	Potassium (per cent)				
19	25	1.915	.436	1.29	.322	380	520	2320
20	50	2.132	.488	0.99	.252	380	640	2580
21	75	2.324	.498	0.76	.308	500	620	1380
22	100	2.114	.634	0.62	.280	360	590	1810
23	125	1.934	.420	1.08	.336	440	670	1550
24	150	1.696	.580	1.09	.336	690	810	1510
25	250	1.916	.422	1.35	.420	880	760	1160
26	350	2.000	.358	0.95	.364	1100	960	1630
27	450	1.898	.396	1.50	.490	1000	980	1590
28	550	2.098	.470	1.13	.504	1010	1070	1220

*NO_3 (nitrate) X .225 equals N (nitrogen)

In conjunction with these data regarding nitrogen, some reference to the phosphorus status may be of interest. One important point is seen in table 2 in that the total phosphorus content of the leaves and petioles appears to increase as the concentration of the nitrate in the culture solution added to the soil increases. The analyses of other leaf samples from these, as well as from other avocado soil cultures grown out-of-doors, confirm the finding that phosphorus absorption by avocado leaves increases as that of nitrogen increases. It was observed however (table 2) that the total phosphorus in the dry matter of avocado rootlets shows somewhat of a decline as the nitrate of the culture solution is increased.

Summary

Soil cultures with seedling avocado trees were grown under glasshouse conditions in order to obtain better control of the factors involved. Culture solutions containing similar concentrations of calcium, magnesium, potassium, and phosphate but a range of nitrate concentrations were applied frequently in large quantities to these soil cultures.

In the nitrate range of 100 to 150 p.p.m. in the culture solution the basal circumference of the trunks reached its maximum, whereas at about 100 p.p.m. nitrate the length of the trunk had reached its maximum. At 150 p.p.m. or more of nitrate the fresh weight of the leaves showed an increase, whereas at 100 p.p.m. the fresh weight of the trunk and branches markedly increased. The dry weights of trunks and branches were at their best in the nitrate range of 100 to 150 p.p.m. In the nitrate range employed, concentrations higher than 100 p.p.m. depressed the root growth.

Total nitrogen values in the dry matter of the petioles of the leaves were greatest at the higher end of the range of nitrate concentrations used in the culture solutions. In the nitrate range of 125 to 150 p.p.m. the first substantial increase occurred in the total nitrogen in the petioles. The leaves of these same cultures and nitrogen range show the first marked change in the intensity of the green color in the leaves.

The total phosphorus content of the leaves and petioles increases and that in the

rootlets decreases as the concentration of the nitrate in the culture solution increases.

1. Haas, A. R. C. Growth in avocado seedlings and the continuity of the nitrogen supply. Yearbook California Avocado Society, 1946: 71-74.