

**Effects of pH on the Growth of Avocado Seedlings**

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The avocado has been included, along with citrus, walnut, and other trees, in a study of the effects of pH on the growth of fruit trees in California. Avocado seed were planted in soil in porous clay pots and were grown until the roots were several inches in length. The seedlings were then washed free of adhering soil and were placed in solution or soil cultures.

Twelve-gallon earthenware containers were used for the solution cultures. These were covered with circular concrete lids about an inch in thickness and divided into halves. The lids were coated with asphalt (Gila-coat) paint and contained, embedded in the concrete, an one-eighth-inch pipe coupling into which a length of pipe was later attached for holding the seedlings in position. Each lid had a three-inch hole in the center to accommodate the two seedlings, which were so placed that the seeds were at the level of the lid and hence barely touched the surface of the culture solution. A half-inch hole near the outside edge of one of the lid halves permitted the introduction of a glass tube extending to the bottom of the container, and thus the means of aerating the culture solution was provided.



Fig. 1—Growth of avocado seedlings in culture solutions. Left, pH adjusted to 4.5; right, pH not adjusted (pH usually in the range 5.5-6.0). Growth of cultures adjusted to pH 6.0 were similar in appearance to the seedlings on the right.

The culture solutions employed had the following composition expressed as parts per million:

Na	K	Ca	Mg	Fe	Mn	B	NO <sub>3</sub>	Cl	SO <sub>4</sub>	PO <sub>4</sub>	Total
7	185	159	54	1	0.1	0.5	718	10	216	105	1455.6

Distilled water was used at all times. The pH of the original culture solution was 4.8 at the start of the experiment on November 5, 1938. Initially the monopotassium hydrogen phosphate was omitted from the solution. When growth slowed somewhat or the burning of leaves became noticeable, the phosphate was added to the cultures. The burning of leaves then ceased and growth took on renewed vigor.

The pH of the culture solution in one container was allowed to shift wherever it would and the pH was not adjusted at any time prior to September 13, 1939. One culture solution was adjusted to pH 4.5 and another to pH 6.0 twice each week with dilute nitric acid or calcium hydroxide solution. In order not to attribute any increase in growth at pH 4.5 to the use of the nitrogen in the nitric acid, other cultures were adjusted to pH 4.5 and 6.0 respectively with dilute sulfuric acid or calcium hydroxide solution.

There was little if any difference in the appearance of the seedlings grown in the culture solutions adjusted to pH 6.0 and that of the seedlings grown in a culture solution the pH

of which was not adjusted. The pH of the culture solution that was not adjusted tended to remain between 5.5 and 6.0.

The leaves of the seedlings grown in the culture solutions adjusted to pH 4.5 were dark green, while the leaves of all the other seedlings were yellowish green and were lacking in vigor. Figure 1 shows the appearance of the plants on May 10, 1939. The roots of the seedlings grown at pH 4.5 (fig. 1) measured 40 or more inches in length as compared with 26 inches for those grown in the unadjusted solution (typical of the seedlings grown at pH 6.0).

In order to study further the effects of pH on the growth of avocado seedlings, an experiment was conducted with soil instead of solution cultures. River soil was obtained near Riverside. The soil was enriched by adding 0.5 lbs. of dried blood for each 50 lbs. of soil. The mixture was screened and thoroughly mixed.

The initial pH of the soil was adjusted by taking known small amounts of the soil and adding to them various amounts of dilute sulfuric acid or sodium hydroxide. After thorough mixing, the pH was determined with a glass electrode. It was hoped to secure a range of pH values in the soil lots extending from pH 3 to 11. Approximation of the final pH values from the small sample trials were not depended upon. Measurements of the pH of the mixed lots of soil showed the actual pH values of the soil cultures.

By the trial and error method, a range of pH values was obtained in soils in 5 gallon containers. Three seedlings of approximately the same initial growth after the germination of the seed were planted in each container of soil.

On December 27, 1938, when the experiment was begun, the pH values of the oven dried (105°C) soil samples at the 1-5 soil-water ratio were: 4.18, 5.90, 8.05, 8.89, and 9.97, respectively. On May 2, 1939, in the same manner the pH determinations gave the values: 4.96, 5.60, 7.25, 7.27, and 7.81, respectively. Such changes in the pH values of adjusted soils are common, some investigators having waited several years for equilibrium to take place.

By means of the glass electrode it was possible to determine the pH (on May 2 1939) of soil samples at the soil moisture content\* prior to the oven-drying. The pH values obtained at soil moisture contents of 18.1, 18.0, 17.1, 13.0, and 21.1 per cent, respectively (the percentages being calculated on a dry-soil basis) was 4.74, 4.93, 6.48, 6.62, and 6.74, respectively. There is reason for believing that the spread of pH values at the soil moisture content was far greater at the beginning of the experiment than on May 2, some four months later.

Growth was distinctly better at the more acid (lower pH) than at the less acid or more alkaline (higher pH) end of the pH range. Figure 2 shows the growth of the avocado seedlings on May 10, 1939, in soils adjusted to various pH values.

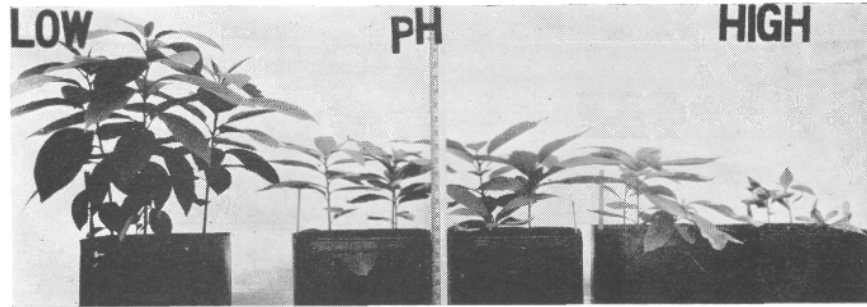


Fig. 2—Effect of soil at different pH values on the growth of avocado seedlings.

It is seen that the avocado seedlings responded very well not only in culture solutions with pH values as low as 4.5 but also in soil cultures having low pH values. Studies are being continued further in the hope of understanding the actual pH at which avocado trees are growing in orchards in the field.

- Those desiring additional information on the pH of soils are referred to articles by Huberty M. K., and A. R. O. Haas, and by the latter alone, printed in the California Citrograph beginning in August, 1939. Those desirous of assisting in the choice of orchards suitable for our studies of soil pH, can consult their county farm advisor.