

THE DUKE AVOCADO

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The Duke variety of avocado has been the subject of considerable interest in recent years because of indications of its partial resistance to Phytophthora root rot. This paper summarizes the history of this variety, and presents information on its distribution, resistance to disease, horticultural properties and other features.

HISTORY — ORIGIN

In the early years of the avocado industry in California, many seeds were brought in from Mexico and other Latin American areas for use as rootstock material. One of the early sites for a small nursery was in Bangor, near Oroville in Butte County, California. Here the Sunnyslope Nursery was established; this is where the Duke variety originated.

The following information on the origin of the Duke has been obtained from several sources. Considerable information has been provided by Dr. J. Eliot Coit. In 1954 the senior author of this paper visited the Oroville area, and obtained additional background on the Duke from A. L. Chaffin, J. W. Cooper, and V. VanDuzer.

It was in 1912 that Mr. Benedict, real estate developer in northern California, imported several hundred avocado seeds for a small nursery planting at Bangor. Dr. Coit suggests that Benedict may have obtained his seeds from Albert Hideout, Whittier nurseryman, who at that time was bringing in many avocado seeds from Sabinas Hidalgo, a Mexican town north of Monterrey which was noted for its avocados. Local sources in the Oroville area say that he selected fruit for good size and appearance and brought in seed from these fruit. The seeds were planted at the nursery site which was west of the town of Bangor, on the north side of the road to Honcut.

The nursery planting was abandoned for several years, until according to Dr. Coit it was purchased by Mr. "Duke" Hornung. Hornung used the land for pasture for several years, then noticed that several of the avocado nursery trees showed signs of life, so cleared the area, selected about 10 trees that looked in the best condition, watered and cared for these.

In 1924 Hornung sent Dr. Coit several fruit from what he considered the best type, a tree bearing sizable green fruit with a thin skin. The fruit looked promising to Dr. Coit, inasmuch as it held up well in shipping and was a good-sized green fruit, so Dr. Coit visited the Oroville area in 1924. The following excerpt is taken from a personal communication from Dr. Coit:

"In 1924 I made a special trip to Oroville to see these trees. Mr. Hornung, whose nickname around Oroville was "Duke," showed me the trees and allowed me to take budwood. The green one I labeled "Duke," and also selected one, a black one, which we labeled "Benedict" after the man who planted the seed. I divided the budwood into two lots. One lot I mailed to the Leucadia Nursery at Encinitas of which I was then part owner and manager. The other lot I sent to Armstrong Nursery at Ontario suggesting that it was well worthy of trial. The Benedict variety failed to bear well and has since become obsolete (note: there are a few trees of this variety still in the Oroville area, and it has been included in the collection at the Citrus Research Center, Riverside). The Duke did so well at Ontario that Armstrong featured it in his catalog for many years as a hardy Mexican, good for home gardens in cold interior locations. I grew a number of nursery trees of Duke and sold some previous to 1929. Some of these, planted in Pasadena, are now tremendous trees and bearing well."

At the time of G. A. Zentmyer's visit to Oroville in 1954, information was provided that a third variety had been selected from the original nursery planting, in addition to the "Duke" and the "Benedict." This was labeled "Number 15;" a tree of this variety was present on the Chaffin property in 1954. Fruit was green, not as large as Duke, and apparently the variety was not propagated extensively.

An article in the 1939 Avocado Yearbook (2) is interesting in relation to possible origin of some Mexican avocado varieties. The article states: "The first seed planted by C. P. Taft was a gift from a Dr. Fairchild who picked the fruit from a Mexican race tree which grew from a seed picked from a tree in Santiago, Chile by Dr. Fairchild in 1899. "The fruit was black, thin-skin and the flavor rich and nutty. The tree was very hardy to cold. There was a very striking resemblance to Benedict. While there is no known record of the source of the several thousand Mexican seed planted by Mr. Benedict, the real estate promoter who established the Sunnyslope Avocado Nursery at Bangor, Butte County, California in 1912, it is not unlikely that a part at least of his seed was purchased from Mr. Taft who was in the seed and nursery business at that time. If such is the case, the Benedict is a second generation seedling from Chile.

"Later Edwin G. Hart secured Mexican seeds from Queretaro, Mexico, and A. R. Rideout and M. Garcia brought in a large amount of Mexican seed from northern Mexico. Thus we find that avocado germplasm of the Mexican race was early brought together in Southern California from Chile, Atlixco and Queretaro. The mixing of these divergent strains by intercrossing here has resulted in a wide multiplicity of Mexican forms ranging from the very small black Mexicola to the large green Duke."

Efforts to obtain more definite information on the possible origin of the seeds from which the Duke variety arose have not been successful. Information on the exact origin of this seed would be valuable from the standpoint of further search for types with more resistance to Phytophthora root rot. With this in mind G. A. Zentmyer has visited Sabinas Hidalgo and several other possible early seed source areas in Mexico. No fruit closely resembling the Duke has been found in Mexico, although several trees have been observed with foliage similar to that of the Duke variety. Collections have been made from such trees, with no indications appearing as yet of any resistance to root rot.

DISTRIBUTION

The Duke variety has been propagated and grown principally in California, where it was of considerable interest in the 1920's and 1930's as an early green, good-sized Mexican fruit with considerable cold-hardiness and wind resistance. In the Alta Loma area Duke trees withstood temperatures of 21 °F during the 1937 freeze and bloomed that spring, while Fuerte trees in the same locations were severely damaged.

Propagation of the Duke has not been continued other than for occasional trees, because of the mediocre quality of the fruit, the somewhat erratic production, and the tendency for the fruit to develop cracks when mature. In California, Duke trees are growing in 12 counties; many of these are scattered back-yard trees that are still producing well. The Duke has been introduced to relatively new avocado growing areas where variations in year-round temperatures may be extreme. As examples, avocado trees in the Hemet area are nearly all Duke; production on a few trees averaged 200 pounds per tree per year over a four year period. The fruit has been sold in local California markets during September and October. Dukes in the Riverside-Arlington area produce fairly well, quality is fair, and maturity is reached in September. The Avocado Variety Committee reported in the California Avocado Society Yearbook for 1940 that the Duke produced good fruit and brought satisfactory prices in the San Fernando Valley and Etiwanda. The trees stood wind, cold and heat better than the average thin-skin variety (5, 6). The largest planting of Dukes is in the Oroville area, with some 230 trees on the A. L. Chaffin property. Reports in the 1940 and 1947 California Avocado Society Yearbooks indicate that the Duke variety was introduced into various other countries, including Argentina, South Africa, and Palestine. A major drawback to the variety in Palestine was its susceptibility to the Mediterranean fruit fly.

MARKETABILITY

The Checklist of Avocado Varieties, as prepared by Marvin Rounds and published in the 1950 Yearbook of the California Avocado Society describes the Duke as follows:

"Duke (Mex.)—Tree originated 1912 from seed planted at Sunny-slope Nursery, Bangor, California. Vigorous, very hardy to cold, wind resistant, productive. Fine for home planting in cold interior districts. Parent tree dead. Fruit season, Sept.-Nov.; color green, weight 8-12 oz; shape pyriform; skin nearly smooth; quality excellent; oil content 21 per cent. Seed medium, sometimes loose."

The quality of the Duke fruit is listed in the checklist as excellent, but this is a point on which there has been considerable difference of opinion. Many people connected with the industry believe the fruit to be of only fair quality. Because of the thin skin the Duke fruit has proven to be a poor shipper; consequently it must be sold on the local market.

Calavo records show an average of 118 field boxes of Duke fruit marketed through their organization over a 20-year period from 1938 to 1958. Prices were often good; for example in the 1947-48 season Duke brought 17.6 cents per pound, compared with 22.1 for Fuerte.

GROWTH HABIT OF TREE

Typically the grafted Duke tree has rather small elongate leaves which usually have a yellowish-green rather than a dark green appearance. Leaves grown in exposed situations range from 4-5 inches long by 2-2½ inches wide. When crushed the leaves

have the typical anise odor of the Mexican type. The tree becomes large (60 to 70 feet tall) with an upright type of growth (Figs. 1 and 2). Duke seedlings vary considerably in size, shape and color of leaves, as well as in type of fruit that they produce.

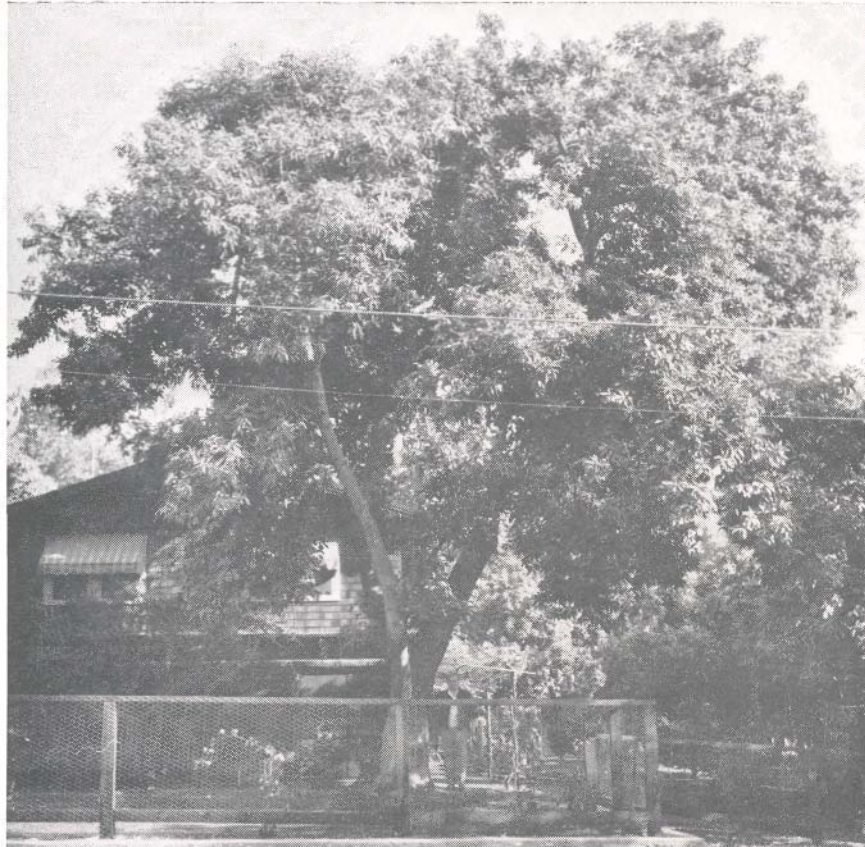


Figure 1. Duke avocado tree 30-35 years old located in Alta Loma (known as Duke Statom #1). Many thousands of seeds have been tested from this tree for root rot resistance (photo December, 1962).

Duke fruit is shiny, yellow-green, and Duke seeds are large for Mexican seed, averaging $1\frac{3}{4}$ -2 inches by $1-1\frac{1}{2}$, with a pronounced point and are often loose in the fruit (Fig. 3). Seed germination is usually less rapid than other common Mexican types such as Topa-Topa and Ganter, and often the seedlings are somewhat slower in development and less vigorous at first than Topa-Topa. This is particularly true of seedlings from selfed Duke seed. This relatively slow germination and early development have been reasons why nurserymen have not used Duke seed extensively.

Winslow and Enderud presented information on flowering and yield of the Duke variety compared to other Mexican types and Fuerte, in the 1955 California Avocado Society Yearbook (7). Duke was classified as an early flowering variety; trees in the experimental planting at Riverside bloomed from February 3 to April 6 in 1951, March 26 to April 26 in 1952, and from February 15 to April 1 in 1953, compared with blooming dates for Fuerte of March 27 to May 25, April 2 to May 16, and March 9 to May 10.



Figure 2. Farm Advisor Clem Meith is shown inspecting the "Hornung" Duke avocado tree near Oroville. This tree was propagated from the original parent Duke tree at the Sunnyslope Nursery, near Oroville.

Of ten varieties under test (Clifton, Duke, Emerald, Fuerte, Halstead, Hass, Irving, Regina, Ryan, and Zutano), Duke, Emerald, Hass, Ryan and Zutano were listed as the best producers. Duke, Emerald and Zutano had the best yield record of the fall and winter varieties.

ROOT ROT RESISTANCE

At the Citrus Research Center, University of California, Riverside, an active program for obtaining resistance to *Phytophthora* root rot has been underway for over 10 years. Tests in lathouse beds containing infested soil, begun in 1951, provided the first indication of some resistance in the Duke variety. Results of these early tests were summarized by Zentmyer and Thorn in the 1956 California Avocado Society Yearbook (10). These tests showed that Duke had considerably more resistance than other avocado varieties such as Topa Topa, Nowels, Tantlinger, Irving, Spinks, Kashlan, Dickinson, and Mayapan, but did not have as high resistance as several other species of *Persea*, including *P. borbonia*, *P. Skutchii*, and *P. Donnell-Smithii*. These latter species are non-graft-compatible with commercial avocado scions, whereas Duke is graft-compatible.

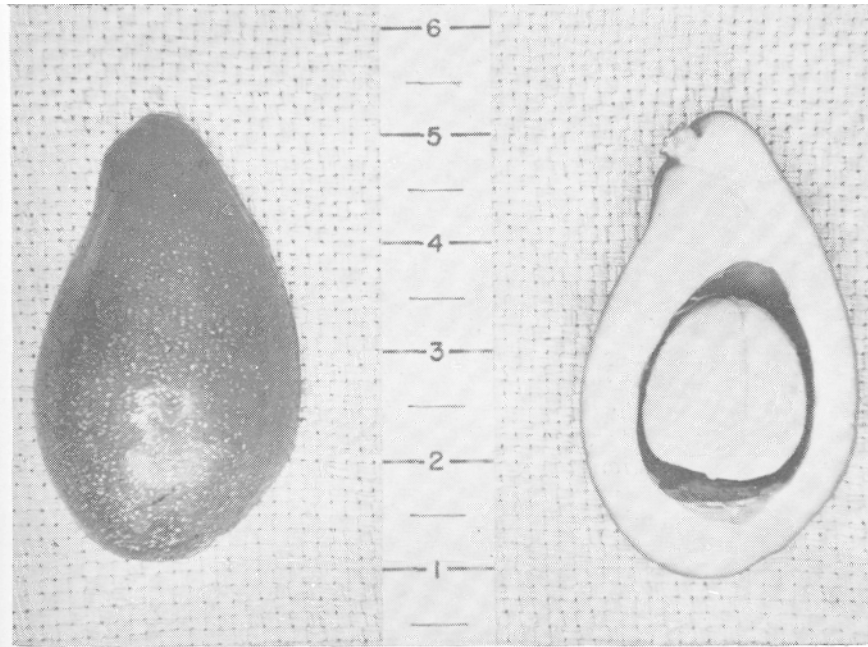


Figure 3. Mature Duke avocado fruit. Note shiny, smooth appearance of skin. The fruit is light green and the seed is often loose when mature.
(Picture—courtesy Jack Shepard, Calavo).

In 1955 Zentmyer and Schroeder (9) presented indications of resistance in Duke seedlings and cuttings planted in root-rot resistance plots on the Riverside and U.C.L.A. campuses. These plots were based on small numbers of trees but did provide evidence of some resistance in Duke.

In recent years most of the screening tests for root rot resistance have been made with the severe nutrient solution method described by Zentmyer and Mircetich in 1960 (8). In this test, resistance of the Duke is not nearly as striking as in the soil tests where disease conditions are not so severe. This indicates that resistance in the Duke is not nearly as high as that in **Persea Skutchii**, **P. borbonia**, and other non-graft compatible species which survive the severe nutrient solution test very well.

In tests with many thousand seedlings in the nutrient solution method over the past several years Duke seedlings show slight resistance but considerably more than Topa Topa as indicated in the table below.

VARIETY	Number of Seedlings tested	Per cent of Seedlings with less than 85 per cent of roots rotted
Duke Selfed No. 1	143	13
Duke Selfed No. 2	421	11
Duke Open No. 1	340	5
Duke Open No. 2	897	4
Topa Topa	597	0.04
Ganter	230	1.5

(Selfed are isolated trees that are self-pollinated)

In the nutrient solution test, Duke cuttings (either from the Duke scion Or from selected Duke seedlings) show more resistance than the average Duke seedling or cuttings of other varieties. Tests were begun with Duke cuttings soon after the first indications of

resistance in Duke seedlings. Most of the cutting material for these tests has been rooted by E. F. Frolich at U.C.L.A. Duke does not root as easily as some avocado types, but can be rooted by the etiolation method developed by Frolich (4).

Over the past 10 years a number of field plots have been established in Los Angeles, Riverside, San Diego, Santa Barbara, and Ventura Counties to test resistance of promising collections under field conditions. These plots have included a large number of Duke seedlings and cuttings, and a few trees grafted on Duke seedling or cutting rootstocks. Preliminary results with these plots, involving nearly 2000 trees, were reported in the 1962 Yearbook by Zentmyer, Thorn, and Burns (11). Correlation between field trials and tests in the greenhouse has been good. It is apparent from these trials that seedlings of Duke are in general more resistant than seedlings of Topa Topa, and that cuttings of Duke (Fig. 4) and of selected seedlings of Duke are more resistant to root rot and more consistent in their reaction than are Duke seedlings. Based on small numbers, grafted trees on Duke rootstock (seedlings or cuttings) appear somewhat more resistant to root rot than grafted trees on Topa Topa rootstock (Table 2).

Table 2. Conditions of trees on Duke and Topa Topa rootstocks in root rot resistance plot in Fallbrook.

Rootstock	Scion	Number of Trees	Average stage* disease 2 years after planting
Duke seedling #1	Hass	8	2.6
Duke seedling #2	Hass	8	3.8
Topa Topa seedling	Hass	8	4.1
Duke seedling #1	Fuerte	8	3.1
Duke seedling #2	Fuerte	8	3.8
Topa Topa seedling	Fuerte	8	4.5
Topa Topa seedling	- - -	28	4.4
Duke cuttings	- - -	6	1.2

* 0=healthy, 5=dead

Another phase of resistance is that of inarching established trees on susceptible rootstocks with more resistant stocks such as Duke seedlings and cuttings. Field plots to test methods of inarching and provide some trials of Duke rootstocks as inarches were established first in 1958, and now involve 27 trees in four of the avocado-producing counties. The approach type graft has been the most successful to date. This project was summarized by Burns et al in the 1961 California Avocado Society Yearbook (1).

The search for the ideal highly resistant, compatible rootstock continues. Much emphasis is still being placed in the resistance program on Duke. Tests are being conducted with additional Duke sources, and larger numbers of cuttings (grafted and non-grafted) are being planted in field plots under severe disease conditions.



Figure 4. W. A. Thorn is shown inspecting the original Duke #6 tree at the Citrus Research Center, Riverside. This tree is a seedling that survived Phytophthora resistance tests; many cuttings have been propagated from this tree.

DUKE AS A ROOTSTOCK

Dr. F. F. Halma included Duke as one of the Mexican varieties in his tests of various avocado rootstocks. Twenty-nine field plots were initially involved in these tests, in various avocado-producing counties. Details of these rootstock trials have not yet been published, but preliminary observations and some data on yields indicate that scions grafted on Duke seedling rootstocks develop into trees similar in productivity and growth to those grafted on other rootstocks.

NUTRITION

Embleton et al reported the relationship between rootstock variety and concentration of chloride in leaves of the scion, in the 1961 Yearbook (3). Their results showed that of the six Mexican rootstocks involved in most of the tests (Blake, Duke, Ganter, Mexicola, Northrop, and Topa Topa) Duke was the best in regard to low chloride accumulation in the scion.

SUNBLOTCH

In cooperation with Dr. J. M. Wallace and R. Drake a number of Duke seed sources and selected seedlings are being tested for the occurrence of sunblotch. Several selected seedlings have already been tested and show no indications of sunblotch. Eleven other

sources of Duke seed are now in process of testing.

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