

CHAPTER II THE AVOCADO



PLATE I. The Nimlioh avocado.

Excerpted (pages 9-78) from

**MANUAL OF TROPICAL AND SUBTROPICAL FRUITS EXCLUDING THE BANANA,
COCONUT, PINEAPPLE, CITRUS FRUITS, OLIVE, AND FIG**

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TABLE OF CONTENTS

	PAGES
THE AVOCADO	3
BOTANICAL DESCRIPTION	4
HISTORY AND DISTRIBUTION	6
COMPOSITION AND USES OF THE FRUIT	9
CLIMATE AND SOIL	11
CULTIVATION	16
Tillage, mulching, and cover-crops	17
Fertilizer	18
Irrigation	20
Pruning	21
PROPAGATION	22
Stock plants	23
Essential features of bud propagation	24
Budding (Fig. 3)	25
Grafting	28
Top-working old trees	28
THE CROP	29
SEASON	31
PICKING, PACKING, AND MARKETING	32
PESTS AND DISEASES	34
RACES AND VARIETIES	38
West Indian race	41
Guatemalan race	42
Mexican race	45
Hybrids	47

THE AVOCADO

NORTH AMERICAN horticulturists are accustomed to view the avocado as one of the greatest undeveloped sources of food which the tropics offer at the present day. From their standpoint they are correct, but the inhabitants of Mexico and Central America would consider it more logical to assert that the Irish potato is a new crop deserving of extensive cultivation. North Americans view the avocado as a possibility, but to the aboriginal inhabitants of tropical America it is a realized possibility.

"Four or five tortillas [corn cakes], an avocado, and a cup of coffee, — this is a good meal," say the Indians of Guatemala.

It is precisely this condition, — the importance of the avocado as a food in those parts of tropical America where it has been grown since immemorial times, — that has led students of this fruit in the United States to predict that avocado culture will some day become more important than citrus culture in California and Florida.

To a certain extent, the avocado takes the place of meat in the dietary of the Central Americans. It is appetizing, it is nourishing, it is cheap, and it is available throughout most of the year. When these last two conditions have been reproduced in the United States, will not the avocado become a staple article of diet with millions of people?

There is every reason to believe that eventually the avocado will be as familiar to American housewives as the banana is today. The increasing scarcity of meat, and the fact that an acre of land will yield a larger amount of food when planted to avocados than it will in any other tree crop known at present, assures the future importance of the avocado industry in this country.

Horticulturally speaking, the avocado is a new fruit. In Central America it has been grown mainly as a dooryard tree, and no care has been given to its propagation or culture. During the last fifteen years the horticulturists of California and Florida have devoted systematic attention to vegetative propagation, to cultural methods, and to the development of superior varieties. In these two states the avocado has been regarded as a fruit of great commercial possibilities. Cuba, Porto Rico, and several other countries are also giving serious consideration to commercial avocado culture.

During summer and autumn the avocado is regularly offered in the markets of New York, Boston, Philadelphia, and other large cities. Many persons who ten years ago were not even familiar with its name have now learned to appreciate the merits of this unique fruit. However, production is not yet great enough to place the avocado in the position which ultimately it must occupy, — that of a staple foodstuff, rather than a luxury or a salad-fruit.

The avocado orchards of California, Florida, Cuba, and Puerto Rico now have a total area approaching one thousand acres. As with every young horticultural industry, the problems of propagation, culture, and marketing have been numerous, and many of them remain to be solved. The avocado growers of California have formed a cooperative organization for the purpose of attacking these problems more

efficiently. Especially important is the question of varieties, which must, in many cases, be settled individually for each locality. Experience of the last fifteen years has brought to light many of the fundamental requirements of the avocado tree and has suggested cultural practices and methods which are producing satisfactory results. In addition, problems of budding and grafting have been mastered, and these means of propagation are practiced successfully by nurserymen, with the result that trees of the best varieties are obtainable in quantities which permit of extensive commercial plantings. A large number of varieties is being tested, and experience in handling and marketing the fruit is being gained rapidly.

BOTANICAL DESCRIPTION

The genus *Persea*, to which the avocado belongs, is a member of the laurel family (Lauraceae); hence it is related to the cinnamon tree, camphor, and sassafras. The avocados cultivated in the United States usually have been considered to represent a single species, *Persea americana*, but careful study shows that they are derived from two species, as follows:

P. americana, Mill. (*P. gratissima*, Gaertn.). All of the varieties classified horticulturally as belonging to the West Indian and Guatemalan races are of this species. It is the common avocado of the tropical American lowlands, and the one which has been most widely disseminated throughout the tropics.

P. drymifolia, Cham. & Schlecht. (*P. americana* var. *drymifolia*, Mez). This includes the small avocados of the Mexican highlands, now grown in California, Chile, and to a very limited extent in southern France, Italy, and Algeria. Horticulturists in the United States use the term "Mexican race" to indicate avocados of this species.

In addition to these two species, a third is well known in southern Mexico and Guatemala, and has recently been introduced into the United States. This is the coyó or chinini, *P. Schiedeana*, Nees. The yás of Costa Rica (probably *P. Pittieri*, Mez) is another species which is likely, when known in this country, to be classed popularly as an avocado.

The two species from which the cultivated avocados are derived are closely alike in many respects. It is easy to distinguish them by the smell of the crushed leaves; those of *P. drymifolia* possess an aromatic odor, resembling that of anise or sassafras, which those of *P. americana* entirely lack. The flowers of *P. drymifolia* are typically more pubescent, and the under surfaces of the leaves more glaucous, than those of *P. americana*. The fruits also are distinct, having a thin, almost membranous skin in the former species, and a thick leathery or brittle skin in the latter. The horticultural differences are of more interest here than the botanical; they will be referred to later, in the discussion of the horticultural races.

Seedling avocados of both species vary in habit of growth, being sometimes short and spreading, but more commonly erect, even slender. On shallow soils they may not reach more than 30 feet in height, while on deep moist clay-loams they sometimes reach 60 feet. Budded trees are usually more compact in habit than seedlings, and probably will not attain such great ultimate dimensions.

While the avocado is classed as an evergreen, trees of some varieties cast their foliage at the time of flowering, the new leaves making their appearance almost immediately. The leaf-blades are multiform, some of the commonest shapes being lanceolate, elliptic-lanceolate, elliptic, oblong-elliptic, oval, ovate, and obovate. The apex differs from almost blunt to acuminate, while the base is usually acute or truncate. The length of the blades ranges between 3 or 4 inches and as much as 16 inches. *P. drymifolia* usually has smaller leaves than *P. americana*, both species exhibiting a wide diversity in leaf form.

In the United States the flowers appear from November to May, according to locality and variety. Occasionally some of the Mexican avocados (*P. drymifolia*) bloom in November, while the Guatemalan varieties (*P. americana*) may not begin flowering until March or April. The flowers (Fig. 1) are produced in racemes near the ends of the branches, and are furnished with both stamens and pistils, all of them being inherently capable of developing into fruits. From their immense number, however, it is easy to see that only a minute percentage can actually do so. They are small and pale green or yellowish green in color. At first glance they appear to have six lanceolate or ovate petals, but on closer examination these are seen to be perianth-lobes; the usual differentiation into two whorls or series, calyx and corolla, does not occur in the avocado. The perianth-lobes are of nearly equal length in most varieties, the inner three occasionally being longer than the outer; they are more or less pubescent, heavily so in *P. drymifolia*, sometimes almost glabrous in *P. americana*.



FIG. 1. Flowers of Fuerte avocado. ($\times \frac{1}{2}$)

The nine stamens are arranged in three series; the anthers are 4-celled, the cells opening by small valves hinged at the upper end. At the base of each stamen of the inner series are two large orange-colored glands which secrete nectar, presumably for the attraction of insects. Inside the stamens are three staminodes or vestigial stamens. The ovary is 1-celled, and contains a single ovule; the style is slender, usually hairy, with a simple stigma.

The fruit is exceedingly variable in both species. The smallest fruits of *P. drymifolia* are no larger than plums, while the largest of *P. americana* weigh more than three pounds. The form in both species is commonly pear-shaped, oval, or obovoid, but ranges from round and oblate at one extreme to long and slender, almost the shape of a cucumber, at the other. The color varies from yellow-green or almost yellow through many shades of green to crimson, maroon, brown, purple, and almost black. The skin is as thin as that of an apple in many varieties of *P. drymifolia*; in *P. americana* it is occasionally a quarter of an inch thick, and hard and woody in texture. The fleshy edible part which lies between the skin and the seed is of buttery consistency, yellow or greenish yellow in color, of a peculiarly rich nutty flavor in the best varieties, and contains a high percentage of oil. The flesh is traversed from the stem to the base of the seed by streaks or fine fibers (invisible in the ripe fruit of many varieties) which represent the vascular system. The single large seed is oblate, spherical, conical, or slender, inverted so that the young shoot develops from the end which lies toward the stem of the fruit. It is covered by two seed-coats, varying in thickness, often

adhering closely to one another. The cotyledons are normally two, occasionally three in *P. drymifolia*, white or greenish white in color, smooth or roughened on the surface.

HISTORY AND DISTRIBUTION

The native home of the avocado is on the mainland of tropical America. *Persea drymifolia* is abundant in the wild state on the lower slopes of the volcano Orizaba, in southern Mexico, as well as in other parts of that country. The extent of its distribution is not precisely known. The native home of *P. americana* has not been determined with certainty, since the tree has been so long in cultivation and few efforts have as yet been made to locate the region in which it is truly indigenous.

Jacques Huber, in the Boletim do Museu Goeldi, says: "Everything indicates that the avocado, originally indigenous to Mexico, has been cultivated since immemorial times, and that it very early spread through Central America to Peru; then into the Antilles, where its introduction is mentioned by Jacquin; and much later into Brazil." He also remarks that its presence in Peru in pre-Colombian days is indicated by the indigenous name, *palta*, and the finding of fruits in the graves of the Incas. W. E. Safford, however, says that no vestiges of the avocado are found in the prehistoric graves of the Peruvian coast, nor is it represented in the casts of fruits and vegetables discovered among the terra cotta funeral vases so abundant in the vicinity of Trujillo and Chimbote.

While it is probable that the avocado is of relatively recent introduction into Brazil, and that its presence in Peru in pre-Colombian days may be open to question, the existence of native names for it in many different languages, as well as references by the early voyagers, indicate that at the time of the Discovery it was cultivated, if not indigenous, in extreme northern South America and from there through Central America into Mexico.

The first written account of the avocado, so far as known, is contained in the report of Gonzalo Hernandez de Oviedo (1526), who saw the tree in Colombia, near the Isthmus of Panama.

Pedro de Cieza de Leon, who traveled in tropical America between 1532 and 1550, mentions the avocado as one of the fruits used by the Spaniards who had settled in the Isthmus of Panama, and as being an article of food among the natives of Arma and Cali, in Colombia.

Francisco Cervantes Salazar, one of the earliest chroniclers of Mexico, gives evidence that the avocado was well known in the markets of Mexico City as early as 1554, which was very soon after the Conquest. In a later work, the "Crónica de Nueva España," written about the year 1575, he described the fruit. Both in this work and in his earlier one, "Mexico en 1554," he uses the name *aguacate*.

Sahagun, another early chronicler of Mexico, who wrote some time previous to 1569, briefly describes the Mexican avocado (*Persea drymifolia*) under the Aztec name, which he spelled *aoacatl*.

Acosta, writing in 1590, distinguished clearly between the Mexican form and that

grown in Peru. He used the Peruvian name *palta*, in place of the Mexican *ahuacatl* or any of its corruptions.

Garcilasso de la Vega, writing in 1605, states that the name *palta* was applied to this fruit by the Incas, who brought the tree from the province of Palta to the valley of Cuzco.

One of the most valuable accounts written in the early days is that of Hernandez, as edited and published by the friar Francisco Ximenez in 1615. Hernandez, who was a physician sent by the King of Spain to study the medicinal plants of Mexico, was evidently familiar only with the Mexican avocado (*P. drymifolia*); at least, if he had seen the lowland species he makes no mention of it.

Another excellent account was written in 1653 by Bernabé Cobo, a priest who had traveled widely in tropical America. He was the first, so far as known, to mention the Guatemalan avocados. After describing at some length the West Indian race, as it is now called, mentioning in particular the varieties grown in Yucatan and those of certain sections of Peru, he says:

"There are three distinct kinds of paltas. The second kind is a large, round one which is produced in the province of Guatemala, and which does not have as smooth a skin as the first. The third is a small palta which is found in Mexico which in size, color and form resembles a Breda fig; some are round and others elongate, and the skin is as thin and smooth as that of a plum."

Thus it is seen that the three groups of cultivated avocados, recognized at the present day by horticulturists under the names of West Indian, Guatemalan, and Mexican, were distinguished as early as 1653 by Padre Cobo.

Hughes, in his important work "The American Physician" published in 1672, devotes a short chapter to "The Spanish Pear." His reference to its having been planted in Jamaica by the Spaniards is in agreement with other accounts, all of which indicate that the avocado was not cultivated in the West Indies previous to the Discovery.

Sir Hans Sloane, in his catalog of the plants of Jamaica, published in 1696, briefly describes the avocado, cites numerous works in which it is mentioned, and gives as its common name "The avocado or alligator pear-tree." This is the first time that either of these names appears in print, so far as has been discovered.

It is useless to enter into a discussion of all the common names which have appeared in the literature of this fruit. G. N. Collins¹ lists forty-three, but many of them are of limited use, and others are the clumsy efforts of early writers to spell the names they had heard.

The correct name of this fruit in English is at present recognized to be avocado. This is undoubtedly a corruption of the Spanish *ahuacate* or *aguacate*, which in turn is an adaptation of the Aztec *ahuacatl*. The Spaniards, who probably introduced the avocado into Jamaica, brought with it the Mexican name. When Jamaica was taken by the British this name began to undergo a process of corruption, during which such forms as *albecata*, *avigato*, and *avocato* were developed. Frequently the term

¹ Bull. 77, Bureau of Plant Industry

"pear" was added to these, in conformity with the tendency of the early English colonists to apply familiar names to the fruits which they found in America. We have many other evidences of this tendency, e.g., star-apple, custard-apple, hog-plum, Spanish-plum.

The name avocado or avocado-pear was one of the numerous corruptions which found its way into print, first appearing, so far as known, in 1696 (see above). For some reason it has outlived many other corruptions.

Since it is reasonably euphonious, well adapted to the English language, and widely used, it has been officially adopted by the California Avocado Association and is used in the publications of the United States Department of Agriculture, as well as by horticultural societies and horticulturists generally. The name alligator-pear, which seems to have appeared in the same way and about the same time as the term avocado, is considered decidedly objectionable, and a vigorous effort is being made to eliminate it from popular usage.



FIG. 2. Sign of the avocado tree used by the Aztecs.

Ahuacate (more commonly but less correctly spelled *aguacate*) is the name at present used in Mexico, Central America as far south as Costa Rica, and the Spanish-speaking islands of the West Indies, as well as in a few other parts of the world. The original form *ahuacatl* is still employed in those sections of Mexico where the Aztec or Mexican language has not been replaced by Spanish. The avocado tree is *ahuacaquahuatl*, a combination of *ahuacatl* and *quahuatl* (tree). There were at least two towns in ancient Mexico named Ahuacatlan. This word was expressed in the picture writing of the Aztecs by means of the sign of the avocado tree and the locative suffix *-tlan*, indicated by teeth set in the trunk of the tree (Fig. 2). The picture thus read *ahuacatlan*, or "place where the ahuacate abounds." The word *ahuacatl* has two meanings; one, the fruit of the avocado tree, and the other, testicle.

The name *pahua* (from the Aztec *pauatl*, fruit) is applied in certain parts of Mexico to avocados of the Guatemalan and West Indian races, distinguishing them from the thinner skinned and smaller *ahuacates* of the Mexican race.

In southern Costa Rica the common name is *cura*, while in the western part of South America the Peruvian name *palta* is current. The latter occurs in the Quichua language, and is of unknown derivation.

The names current in various European languages are mainly adaptations or corruptions of the Spanish *ahuacate* or *aguacate*. The Portuguese name, used principally in Brazil, is *abacate*; the French generally call the fruit *avocat*, while the German name is *advocado* or *avocado*.

In all probability the avocado was brought to Florida by the Spaniards, but the first introduction of which a record has been found was in 1833, when Henry Perrine sent trees from Mexico to his grant of land below Miami.

The first successful introduction into California is believed to have been in 1871, when R. B. Ord brought three trees from Mexico and planted them at Santa Barbara. It seems strange that so valuable a fruit should not have been introduced into California by the Franciscan padres, who came from Mexico in the latter part of the

eighteenth century and to whom credit is due for the introduction of the orange, the olive, and the vine.

According to Higgins, Hunn, and Holt², the avocado was grown in Hawaii as early as 1825, although it did not become common until after 1853.

The avocado is now cultivated to a very limited extent in Algeria, southern Spain, and France, and has even fruited in the open at Rome. Naturally, only the hardiest varieties succeed in the Mediterranean region. In India and other parts of the Orient it has never become common, although it may have been introduced as early as the middle of the eighteenth century. In Réunion and Madagascar it seems to be more abundant. In Polynesia it has become well established, considerable quantities of the fruit having been shipped from the French island of Tahiti to San Francisco. It is gaining a foothold in northern Australia, and is grown in Natal, Mauritius, Madeira, and the Canary Islands. In the Philippines its culture has been established since the American occupation, many varieties having been introduced by the Bureau of Agriculture.

While it will thus be seen that the avocado has spread from its native home entirely around the globe, it is still most abundant, and of the greatest importance as a food, in tropical America. Throughout Mexico, Central America, and the West Indies seedlings are common in dooryards, thriving with practically no attention and yielding generously of their delicious and nourishing fruits. Rarely in these countries, however, has the avocado been developed as an orchard crop; but this is not surprising in view of the fact that orchards of fruit trees are almost unknown in the tropics.

COMPOSITION AND USES OF THE FRUIT

Due to the investigations of M. E. Jaffa and his associates at the University of California, much light has been thrown on the food value of the avocado in recent years. The following table shows the composition of several well-known varieties, one of each of the recognized horticultural races, and the hybrid Fuerte. In presenting this table, which is based on the work of Jaffa, it is necessary to explain that the proportions of the constituents have been found to change in each variety according to the degree of maturity of the fruits. They may fluctuate also in different years. Variation is particularly noticeable in regard to the fat-content. For example, in specimens of the Chappelow examined at different times, the percentage of fat ranged from approximately 14 to 30, while in specimens of the Challenge it ran from 3 to 17. Fruits showing the lowest percentages were immature at the time the analyses were made, but they were no more so, probably, than many which are put on the market. Up to a certain point, the fat-content increases with the maturity of the fruit; after this point is reached, there is quite often no further increase, no matter how long the fruit may remain on the tree.

The total dry matter in the edible portion of the avocado is greater than in any other fresh fruit, the one nearest approaching it being the banana, which contains about 25

² Bull. 25, Hawaii Agr. Exp. Sta.

per cent. An average of twenty-eight analyses showed the avocado to contain about 30 per cent.

TABLE I. COMPOSITION OF AVOCADO VARIETIES

VARIETY	WATER	PROTEIN	FAT	CARBO-HYDRATES	ASH
	%	%	%	%	%
Trapp (West Indian)	78.66	1.61	9.80	9.08	0.85
Sharpless (Guatemalan)	71.21	1.70	20.54	5.43	1.12
Puebla (Mexican)	63.32	1.80	26.68	6.64	1.56
Fuerte (Hybrid)	60.86	1.25	29.14	7.40	1.35

The protein-content, which has been found to average about 2 per cent, is higher than that of any other fresh fruit.

The percentage of carbohydrates is not high compared with that of many other fruits, because the avocado contains almost no sugar. F. B. La Forge of the Bureau of Chemistry at Washington has found in the avocado a new sugar, called D-Mannoketoheptose, which is believed to be present in amounts varying from 0.5 to 1 per cent.

The amount of mineral matter is much greater than is found in other fresh fruits. Soda, potash, magnesium, and lime compose more than one-half the ash or mineral matter, which places the avocado among the foods which yield an excess of the base-forming elements, as opposed to nuts, which furnish acid-forming elements in excess.

Jaffa³ says: "So far as protein and ash in fresh fruits are concerned, the avocado stands at the head of the list, and with reference to the carbohydrates, contains on an average fully 50 per cent of that found in many fresh fruits. These facts alone would warrant due consideration being given to the value of the avocado as a fresh fruit. Its chief value as a food, however, is due to its high content of fat. This varies, as shown by the analysis, from a minimum of 9.8 per cent to a maximum of 29.1 per cent, with an average of 20.1 per cent. The only fruit comparable with the avocado in this respect is the olive."

Experiments carried on at the University of California have shown that the digestibility of avocado fat is equal to that of butter-fat, and not below that of beef fat.

As to the caloric or energy-producing value of the avocado in twenty-eight varieties examined, one pound of the flesh represents an average of 1000 calories. The maximum and minimum were 1325 and 597 respectively. The maximum "corresponds to about 75 per cent of the fuel value of the cereals and is not far from twice that noted for average lean meat."

In the following table the avocado is compared, in caloric value, with several common foodstuffs. For this comparison a pound of avocado flesh has been considered to represent 1000 calories; this is not showing the avocado at its best,

³ Bull 254, Calif. Agr. Exp. Sta.

for, as just stated, in some varieties a pound represents over 1300 calories:

	CALORIES
100 grams (about 3½ oz.) boiled rice	322
100 grams white bread	246
100 grams avocado	218
100 grams egg	166
100 grams lean beef	100

It must not be assumed from the figures that the avocado has a total food value greater than that of lean beef. It is only the caloric or energy-producing values that are shown, and much of the value of meat as a food lies, of course, not in the energy which it produces, but in its ability to build up and repair the tissues of the body.

In the United States the avocado is commonly used in the form of a salad, either alone or combined with lettuce, onions, or other vegetables. Up to the present, no satisfactory ways of cooking or preserving this fruit have been developed. Experiments in extracting a table or cooking-oil have been encouraging, but as yet the production of avocados in this country is not great enough to permit the commercial development of this field. In the tropics, the fruit is added to soups at the time of serving; mashed with onions and lemon juice to form the delectable guacamole of Cuba and Mexico; or eaten as a vegetable, without the addition of any other seasoning than a little salt. In Brazil it is looked on more as a dessert than as a staple foodstuff, and is made into a delicious ice-cream. Numerous recipes appear in cook-books which have been published in Cuba, Florida, California, and Hawaii.

CLIMATE AND SOIL

It is impossible to define in few words the climatic conditions most favorable to the avocado, since the different races do not always succeed under the same conditions. The subject must, therefore, be considered from the standpoint of races.

The West Indian race, which comes from the moist lowlands and seacoasts of tropical America, is more susceptible to frost than the others. Hence, when grown near the northern limit of the subtropical zone, it requires more protection from possible severe frosts than the Guatemalan race, which comes from the highlands of southern Mexico and Guatemala, or the hardy avocados from central and northern Mexico which constitute the Mexican race. Not a few losses have already resulted from attempts to grow West Indian avocados in locations in California subject to occasional severe frosts. In this state, the Guatemalan and Mexican races are the only ones to plant. The same is true of central and northern Florida, where the West Indian race has nearly always succumbed to cold.

In Florida, the region in which avocado culture is at present conducted commercially lies south of Palm Beach on the east coast and south of Tampa Bay on the west. Of the orchards which are now in bearing, the largest are situated close to Miami and Homestead. On the west coast the most important plantings are near Fort Myers. Most of the orchards in Florida are planted to Trapp, a variety of the West Indian race. The planting of hardy Guatemalan kinds will probably extend the commercial culture of this fruit many miles to the northward of the present limits of

the zone. In addition, it will make avocado growing safer in all regions by lessening the possibility of frost injury. The Mexican race is known to have fruited as far north in Florida as Gainesville and Waldo.

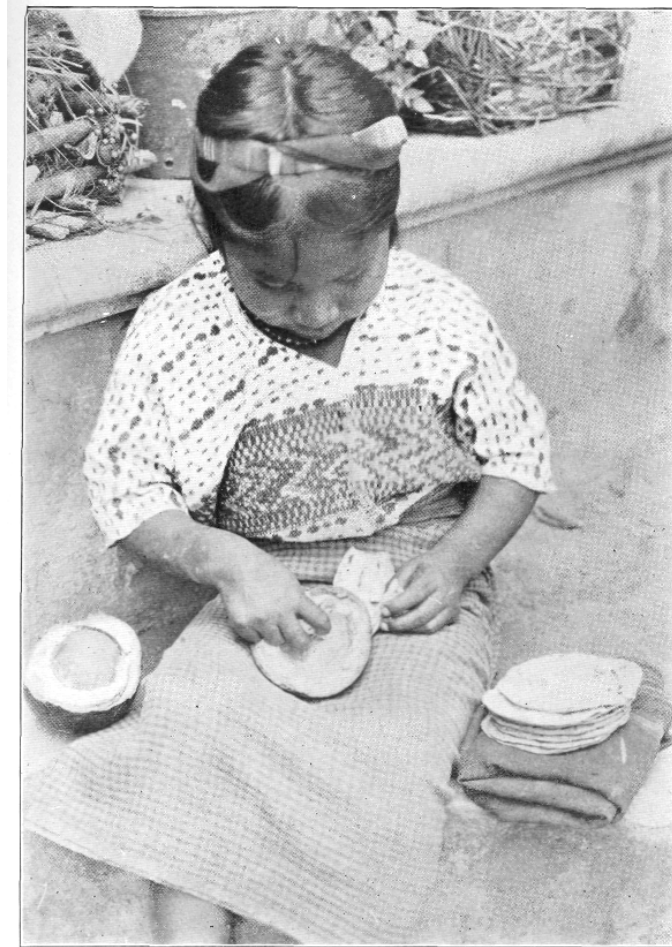


PLATE II. Four or five tortillas (corn cakes) and a good-sized avocado are considered a good meal by the Guatemala Indians.

In California, most of the young orchards, as well as the old seedlings which have fruited for some years, are in the vicinity of Los Angeles, Orange, and Santa Barbara. The coastal belt between Santa Barbara and San Diego, including the foothill region some distance from the coast, has been tested sufficiently to show that planting may proceed with confidence. In the interior valleys comparatively few trees have been planted, and these mainly in recent years. Much less is known, therefore, regarding the adaptability of the avocado in these situations. Old seedlings are to be seen at Visalia, San Luis Obispo, Berkeley, Los Gatos, and Napa, indicating that some varieties may be grown successfully as far north as the Sacramento Valley. Sections of the San Joaquin Valley which have proved suitable for citrus culture, such as the Porterville district, should prove safe for the hardier varieties of avocados as well. Experimental plantings in the Imperial and

Coachella Valleys have up to the present served only to indicate that the atmosphere of these regions is too dry. The leaves turn brown and fall off, no matter how much water is applied at the root.

As a guide to planters in regions where the avocado has not been tested, it may be said that experience has shown the Guatemalan race to be about as hardy as the lemon. Certain kinds probably are hardier than that, while others are known to be tenderer. The Mexican race, in its hardier varieties, withstands a little more frost than the orange. The West Indian race is distinctly tenderer than either the Guatemalan or Mexican.

W. J. Krome's experience at Homestead, Florida, leads him to say: " As a general rule West Indian avocados, beyond one year old, will not be damaged by a temperature of 32° unless that temperature holds for a longer period than two or three hours. When four or five years old they will stand 26° or 27° without injury, except to tender growth, but below that temperature there is likely to be considerable damage. At 22° five-year-old Trapp trees were killed back to wood one inch in diameter. At temperatures somewhere between 22° and 24° Guatemalans have, with a few exceptions, shown almost no damage beyond a slight singeing of the leaves."

In the Report of the California Avocado Association for 1917, H. J. Webber publishes the following summary of the effect of different temperatures on avocado trees in California in the cold weather of the winter of 1916-1917:

- "30° F. Nothing injured so far as could be observed.
- "29° F. No injury of account; only traces on most tender growth of West Indian and Guatemalan varieties.
- "28° F. New foliage scorched on Guatemalan types; West Indian varieties showing considerable damage.
- "27° F. Mexican varieties with new tips slightly scorched; Guatemalan -with almost all new foliage injured; West Indian badly damaged.
- "25° to 26° F. Mexican varieties with new foliage injured but some dormant trees uninjured; all Guatemalan sorts with new foliage badly injured and some old foliage scorched.
- "24° F. Some dormant Mexicans uninjured; Guatemalan varieties badly injured, small limbs frozen back.
- "21° F. All Guatemalan types killed to bud; a few of the hardiest Mexicans, such as Knowles and San Sebastian, with young leaves only injured. "

The observations reported to Webber showed that young trees were injured at higher temperatures than older ones, when the variety was the same in both cases. It was also observed that trees in rapid growth were more severely injured than those which were in semi-dormant condition. Krome of Florida reports an opposite state of affairs. He says: "At the time of the January 1918 freeze, Trapp trees which had borne heavy crops and were in a hard, completely dormant state suffered a great deal more injury than trees which, owing to light crops the preceding season, were in full growth." Possibly the trees were weakened by over-production of fruit, and thus more susceptible to frost-injury. The subject demands further investigation.

Webber further says: "Trees which needed irrigation when the freeze came suffered rather severely, as did also trees that had been irrigated three to five days before the freeze and were thus gorged with water. The least injury seemed to be on trees

that had been thoroughly irrigated two or three weeks before the freeze, and had water supposedly in what might be termed the optimum amount."

In regions subject to frosts, it is necessary to protect the trees during the first two or three winters with shelters of burlap, or by placing palm-leaves, pine boughs, or other material around them. Frost-fighting with orchard heaters is sometimes practiced where heavy frosts are expected.

A sharp frost at the time the tree is in flower may result in a crop failure, although the danger from this source is probably not great either in California or Florida, and has been over-estimated in the past. In Florida, the West Indian race usually blooms late enough to escape the coldest weather, while in California the Mexican race, though it blooms in winter, is sufficiently hardy to withstand ordinary frosts, and the Guatemalan race does not bloom until April or May. The latter race is, therefore, the safest in this respect.

In California, avocado culture is not dependent on rainfall, since irrigation is commonly practiced. In Florida, on the other hand, very few crops are irrigated, and up to the present it has been the general custom not to irrigate avocado trees, except during the first two or three summers. It is coming to be recognized, however, that a wet spring is followed by a good avocado crop and a dry one by a poor crop (a condition exactly reversed with the mango). As a result of this observation, irrigation is beginning to be practiced in southern Florida, especially in seasons when the rainfall is below normal.

The necessary soil-moisture can be supplied easily and satisfactorily, but the relative humidity of the atmosphere cannot be altered artificially; hence in regions where the humidity is exceedingly low the avocado suffers in the dry portion of the year. In Florida no attention need be paid to this subject, since the humidity closely approaches that of the West Indies and other regions where the avocado is at home. Humidity may prove, however, to be the limiting factor in parts of California. Tests in the Imperial and Coachella Valleys indicate that the trees are seriously injured by the dryness of the atmosphere. Experience shows that the Mexican race is less susceptible than the West Indian. None of the varieties so far tested, however, has proved to be so resistant to atmospheric dryness as the orange or grapefruit. Shading may help to limit the injury from this source. It has been found very beneficial in the coastal belt of California, where young avocado trees are often injured during the dry summer months by sunburn.

Another climatic factor which deserves consideration is the danger from high winds. The lower east coast of Florida is occasionally visited by a West Indian hurricane which defoliates trees, strips them of their crops, or even breaks them down. Certain parts of California are also subject to occasional high winds, less severe than the hurricane but nevertheless capable of doing much damage. To minimize the danger from this source, it is advisable to keep the trees as low as possible through pruning, since they are then much less liable to injury. The low tree has an additional advantage in that it permits of picking the fruit without the use of tall ladders, and keeps the branches more readily accessible for pruning, spraying, or thinning the fruit.

In regard to soil the avocado seems to be unusually adaptable, succeeding on the sandy lands of southern Florida, the volcanic loams of Guatemala and Mexico, the red clays of Cuba and Guatemala, the granite soils of California, and even on heavy adobe, provided the drainage is good. This question is less important, therefore, than many others connected with avocado culture. The chief requisite is good drainage.

Most of the avocado groves of southeastern Florida are situated upon limestone of the kind shown as Miami oölite. This formation comprises a narrow strip of land extending from above Fort Lauderdale on the north to some miles below Homestead on the south, being widest near the latter place, and nowhere more than thirty feet above sea level. In many parts of this region the rock comes to the surface; toward the northern end it is commonly overlaid with six inches to two feet of loose light-colored quartz sand, while below Miami the surface soil becomes very scanty, but heavier in nature, containing some clay in certain localities, and being strongly impregnated with iron, giving it a reddish color. The rock itself is soft and porous, and in the process of erosion has broken down unequally, leaving a jagged surface or the characteristic pothole formation. When first grubbed it crumbles and is readily worked, but on exposure to the air it gradually hardens, owing to the deposition of carbonate of lime following evaporation of the moisture held in the interstices.

The growth made by the avocado upon this rocky land is rather remarkable; it seems, in fact, that young orchards have done better around Homestead, where the rock comes to the surface, than they have in those areas north of Miami where there are six to eighteen inches of sand on top of the rock. The reason for this may lie in the moisture-retaining properties of this soft limestone; the roots, which are always close to the surface, here probably are kept more uniformly supplied with moisture during a period of dry weather than on light sandy soils which dry out rapidly.

The heavier Florida soils seem to be much more favorable to the growth of the tree than light sands. Yellowish or brownish subsoil in many parts of Florida indicates good avocado land. The avocado prefers a moist heavy loam, and the closer this can be approached the better will be the results.

The soils of California are probably more nearly ideal for avocado culture than any of those in southern Florida. Sandy loam, which is abundant in the southern part of the state, produces excellent growth and is giving good results. Adobe does not seem so desirable, yet good trees have been grown upon it at Orange.

Red clay has been satisfactory in Cuba and Central America, while heavy clay where well drained has produced good trees in Puerto Rico.

Many problems connected with avocado culture remain to be solved. One of the most important is the adaptability of the tree to low wet lands in southern Florida. It has been the general opinion that avocados should not be planted on land where the water-table is less than three feet below the surface. Krome has observed groves on low rock-land which have been killed or badly injured by overflows, even where the water came scarcely as high as the crown roots and remained there only a few days, in several plantings on marl prairie, however, experience has been quite different. Trees on this type of land have been submerged twenty-four hours without

damage to them. On the low islands along the western coast of Florida, salt water sometimes floods the groves, and this has proved fatal to many trees. It is probable, also, that the failure of one or two plantings on this coast can be attributed to the fact that the water which stands about two feet below the surface of the land is saline in character.

Until more experience has been gained regarding the adaptability of the avocado to low flat ground, occasionally subject to overflow, orchard plantings should be limited to lands where the water-table is three feet or more below the surface.

In California, the best site for the orchard is a gently sloping hillside, or level ground adjacent to a slope. If of this character and well drained but naturally retentive of moisture, the situation may be considered excellent. In regions subject to heavy winds, it is well to select a piece of ground which is sheltered by surrounding elevations.

CULTIVATION

Regarding the best time to plant avocados in southern Florida, Krome says:

"I have planted at least a few avocados every year since 1905 and these plantings have been made during every month of the year. When I have the land prepared and the trees available I do not hesitate to plant at any season but I endeavor to make my arrangements so that all of my main settings will be between the 15th of September and the 20th of October, i.e. during the last month of the regular rainy season, after the hottest weather of the year is past. When avocados are planted in the spring in Florida they have immediately ahead of them our most trying months of drought, March, April and usually most of May. During this period the plants must be watered with the greatest regularity or they will suffer. Following the dry weather of our spring months the trees have the benefit of the rainy season but in Florida our rains are quite frequently uncertain during July and August and there will be need for watering any trees planted during the preceding three or four months. For the past month (June) we have averaged at least two applications of water per week to avocados planted during March, April and May. These spring-planted trees must also withstand the sun's rays during our season of greatest heat and shading is usually a necessity if sun-scald is to be prevented. There are no good reasons why trees thus planted should not be brought through to fall in good condition but it requires a great deal of additional work and expense as compared with trees planted during the latter part of September or first half of October, when rains are of almost daily occurrence and the plants after setting need very little further attention. Furthermore, spring-planted trees very seldom make sufficient growth over those planted in the fall to acquire any considerably greater degree of resistance to cold the following winter. I have always found that trees planted in March fare just about as badly as those planted in September when we have severe cold the next winter."

In California it is not desirable to plant earlier than March, because of danger from late frosts. April and May are good months, and November planting has been successful. Planting in midsummer is to be avoided, but it may be done successfully if the trees are carefully shaded and watered until they have become established.

Avocados are sometimes interplanted with other fruit-trees, such as grapefruit and

mangos. This is scarcely to be recommended, since avocados require different cultural treatment.

In Florida, budded avocados are planted 20 by 20 feet (108 to the acre) to 26 by 26 feet (64 to the acre), some growers preferring to have the trees close together so that they will soon shade the ground, others desiring to give more room for ultimate development. On light sandy soil the trees are usually set closer than on heavy soils, 20 by 20 feet being a suitable distance in the first case, 24 by 24 in the second. In

California they should not be spaced closer than 24 by 24 feet, making 75 to the acre; 30 by 30 feet (48 to the acre) is preferable.

Holes for planting should be prepared a month in advance, with a small quantity of fertilizer incorporated in each. Barnyard manure is commonly used for this purpose in California, while South American goat manure and pulverized sheep manure, 2 or 3 pounds to each hole, have proved satisfactory in Florida.

In planting, the tree should be set so that the point of union between the bud and the seedling stock is slightly above the surface. Deeper planting may not be objectionable in California, but in Florida shallow planting seems to be best. A liberal watering should be given immediately after planting.

Tillage, mulching, and cover-crops.

The ground around the young trees should be kept liberally mulched with weeds, straw, barnyard litter, seaweed, or any coarse material which is not injurious and will not pack and form a layer impervious to air and water. Through the winter mulch is not necessary in California, but in Florida it has been found desirable, in some sections at least, to maintain one throughout the year. In Puerto Rico, G. N. Collins observed that the avocado tree was seldom, if ever, found in perfectly open places, with the bare ground around the roots exposed to the sun. While this principle applies more particularly to Florida and other regions distinctly tropical in character, it may be proved to hold good in California as well. Definite knowledge on this point is still lacking. Up to the present it is the practice of many California orchardists to cultivate the soil regularly after each irrigation, as with citrus fruits. Deep cultivation seems to produce no harmful results in California, where the roots go far down into the soil, but in southern Florida it must be practiced with caution. In this region the feeding roots extend practically to the surface, and deep cultivation destroys many of them, thus cutting off a large part of the tree's food supply. On shallow soils the most healthy and vigorous trees are those which are mulched. The mulch should extend at least two feet in each direction from the trunk of the young tree, and as the latter increases in size and its roots reach out on all sides, the mulch must be enlarged to be always a little wider than the diameter of the crown.

Mulching serves two purposes: it prevents the soil from drying out rapidly, and it protects the delicate feeding roots from injury due to excessive heating of the soil. This protection is of particular importance in Florida, where in many places the land is sandy and becomes exceedingly hot if exposed to the sun.

When the trees are of mature size, the shade furnished by their own foliage, together with the fallen leaves which carpet the ground, aids materially in maintaining the soil in good condition; but additional loose material, especially during the summer, is highly desirable.

The use of green cover-crops between the rows is decidedly beneficial, but they must not be brought close enough to the trees to rob them of their food. In Florida, cowpeas and velvet beans have been used for this purpose, cowpeas being preferred. A clump of pigeon peas (*Cajanus indiens*) planted four feet to the south of each young tree will provide shade during the first summer or two, serve as a protection from wind, and aid in enriching the soil. In California, purple vetch (*Vicia atropurpurea*), common vetch, and the other covercrops used in citrus culture will probably prove satisfactory. Up to the present time they have not been extensively tried in connection with avocado culture.

Fertilizer.

Little systematic attention has yet been given to this subject. Not only is the question difficult, but it is also one of the most important in connection with avocado culture in Florida. The following extracts from a paper by Krome, published in the 1916 Report of the California Avocado Association, present the results of several years of experimentation:

“The nature of the plant food required by the avocado has not been very satisfactorily determined, but it has become evident that a scheme of fertilization must be worked out differing considerably from that which has been generally adopted for citrus. Broadly speaking the application of commercial fertilizers deriving their elements of plant food from wholly chemical sources has not proved successful. In many instances, through lack of more definite information, growers have given their avocados the same fertilizers which they have used on their citrus trees. Where the formulas have been those most frequently applied to citrus, with nitrogen derived from sulphate of ammonia or nitrate of soda, potash from sulphate of potash, and phosphoric acid from acid phosphate, the results with the avocado have been generally unsatisfactory. However, when the formula used has been of the type known as 'young tree ' fertilizer, carrying a proportionately higher percentage of ammonia largely derived from organic sources, better effects have been obtained.

“It has become fairly well established as a fact that of two avocado trees of the same variety, one which is well nourished and kept in growing condition during the entire summer and fall will produce larger and finer appearing fruit than one which is permitted to become more or less dormant through lack of fertilizer, but it is quite certain that the semi-dormant tree will carry its fruit without dropping for a considerably longer time. There is therefore a rather delicate adjustment to be made in order to bring the tree into condition such that it will hold its crop until late in the season and at the same time will not 'go back' to an extent that will be seriously detrimental to its further development or jeopardize the crop for the following season. "Following such applications of fertilizer as are made to restore the tree to good condition after it has passed through the period of bloom and fruit setting there should certainly be at least one further fertilizing during the summer or early fall to provide the nourishment necessary for the production of the crop. And it may be added here that the drain on

an avocado tree in bringing its fruit to maturity seems to be vastly greater in proportion than the same effort on the part of a citrus tree. The writer cannot vouch for the soundness of the theory, but it has been thought that this is probably due to the different character of the fruit. In the case of any citrus, water constitutes a large percentage of the fruit either by weight or volume, while with the avocado the proportion of oils is much higher and it would seem reasonable that to supply these components would be a heavier draft upon the tree. At any rate the fact is certain that an avocado tree must be furnished with a sufficiency of plant food if it is to be expected to produce full and regular crops.

“Avocados of the West Indian type begin to ripen in Florida about the middle of July and the heaviest portion of the seedling crop matures between August 20th and October 10th. At that period the crop from Cuba and other West Indian islands is likewise being shipped and the large quantity of fruit thus thrown on the market, together with the fact that during the summer and early fall the avocado must compete with northern-grown fruits and vegetables, tend to force prices so low, that at times it is difficult to dispose of the Florida seedlings with any margin of profit. After the middle of October the price of avocados begins to climb and during November and December very satisfactory figures are usually obtained. For this reason the large plantings of budded trees which have been made during the past few years have practically all been of late maturing varieties such as the Trapp and Waldin. These varieties mature their fruit so that it may be picked early in October if desired, but under proper conditions will carry at least a portion of their crop into December and in some cases until well along in January.

“Just how late in the season an application of fertilizer can be made without bringing about a tendency for the tree to mature and drop its fruit at too early a date depends somewhat on weather conditions. Fertilizer applied to Trapp trees about the middle of August of the season just passed, apparently had no detrimental effect as to the fruit holding well, while an application of fertilizer given the same trees about the first of September of the preceding year was followed, within a few weeks, by heavy dropping of fully matured fruit. The application made in August of the present year was at the beginning of several weeks of dry weather, while that of the previous season was followed by heavy rains and these differences in moisture probably had considerable to do with the effects of the fertilizer.

“This second problem is one of great importance to the Florida avocado grower as between December 1 and December 15 the value of his product not infrequently more than doubles and the premium to be gained by being able to carry his fruit until the latest possible date is well worth his very best efforts.

“It is our plan at Medora Grove to give the trees a heavy fertilizing immediately after the crop has been picked and a light application about the first of February, which brings them to their blooming stage in good condition, quite thoroughly recuperated from their fast during the fall.

“This program provides for five or six applications of fertilizer during the year, which is probably one or two more than is given by most growers, the difference being in the method of carrying the trees through the spring period. The quantity of fertilizer used at each application varies of course with the size of the tree, quantity of fruit it is carrying and the analysis of the fertilizer. For ten year old trees as high as 25 pounds at a single application has been used with good results. For four year old trees, bearing their first crop, four applications of from three to four pounds each, one of four and one-half and

one of five pounds have brought the trees through the year in fine shape. As materials from which fertilizers suitable for avocados may be compounded, cottonseed meal, castor pomace, tankage, ground tobacco stems and ground bone are to be recommended, with a certain amount of nitrate of soda used as a source of nitrogen when quick results are sought as in the case of trees which have 'started back.' Previous to the war scarcity of potash, it was thought advisable to use formulas giving from four to six per cent of that element, but the enforced limitations to the percentage of potash obtainable during the past two years has had no apparent ill effects upon the trees or fruit and seemingly a range of from zero to four per cent will provide all the potash that an avocado tree requires under Florida conditions. A formula that has given good results is built up of cottonseed meal, castor pomace, tankage, and ground tobacco stems, analyzing 4 per cent to 5 per cent ammonia, 6 per cent to 7 per cent phosphoric acid and 2 per cent potash.

"The trees were usually cultivated by hoeing three times each year and a heavy mulching of dead grass or weeds during the dry winter season. If instead of the dead grass a mulching of compost or well rotted stable manure is used the results are even more satisfactory and the February application of fertilizer may then be omitted entirely."

In California, stable manure has been practically the only fertilizer used up to the present. The necessary nitrogen can be obtained from this source, and the organic matter added to the soil is also of benefit.

Irrigation.

An abundance of water is especially important during the first two or three years after the tree is planted, if rapid healthy growth is to be maintained. In Florida, particularly in sections where the soil is deep, many young groves have in the past suffered for lack of water. One of the most experienced growers near Miami states that trees which have had abundant irrigation are as large at four years of age as non-irrigated trees at six years. Their larger size enables them to yield commercial crops earlier than non-irrigated trees.

In California it is the general practice to irrigate avocados in the same manner as citrus fruits. The amount of water necessary for maximum development varies considerably on different soils, but during the first few years a thorough irrigation every ten days during the dry season is not too much.

The importance of an abundance of moisture in the soil at the time the fruit is setting has already been mentioned in the discussion of the climatic requirements of the avocado. Several crop failures in Florida have been blamed on unusually dry weather during this period. A drought probably does little harm if it occurs when the trees are just beginning to bloom, but if it continues the flowers are likely to drop and the crop to be a failure. This has been the experience with Trapps when grown on deep sand; on heavy soils, which are more retentive of moisture, the danger is less.

In order to avoid crop failures from this cause, the grower should certainly be prepared to irrigate at the time the fruit is setting. In southern Florida this is usually in March and April. When a prolonged dry spell occurs just at this time, as is

sometimes the case, two or three thorough irrigations, a week apart, may suffice to save a considerable amount of fruit.

In California, if the soil is allowed to become too dry during the hot summer months, young trees are frequently given a setback from which they are slow to recover. This has been observed in Florida as well, particularly on deep sandy soils.

The method of applying water varies in different regions. In California the basin system is commonly used, especially when the number of trees to be irrigated is small. Basins should be filled with coarse strawy manure to serve as mulch. In many orchards the trees are irrigated by the furrow system which is used with citrus fruits, the soil being cultivated after each irrigation. In southern Florida other methods are made necessary by the fact that water cannot be run in furrows over the sandy soil. Revolving sprinklers, placed at the proper distance so that all the ground will be covered by their spray, are sometimes employed. Where economy of water is a factor, these are less desirable than the basin system. Taken in all, it seems that the best method of irrigating is to form around the tree a basin as wide as the spread of the branches (or wider during the first two years), to fill it with weeds, straw, manure, seaweed, or other loose mulch, and then to apply water at least once in two weeks when the rainfall is not sufficient to maintain the tree in good growing condition.

Pruning.

The amount of pruning required by the avocado depends largely on the variety. Some make short stocky growths and form shapely trees without the assistance of the pruning shears, while others take long straggling shapes and do not branch sufficiently to form a good crown. These latter must be cut back heavily. Trapp and other varieties of the West Indian race in general, usually make low stocky trees, branching abundantly and forming plenty of fruiting wood. With such forms, pruning is reduced to the minimum, consisting principally in removing fruit-spurs which die back after the crop has been harvested, and in the occasional cutting back of a branch to produce a crown of symmetrical form and good proportions. Beyond this very little pruning is done in Florida orchards.

With the Guatemalan race, more training is often necessary to produce a tree of ideal proportions, since some varieties tend to make long un-branched growths. In others the lateral branches are very weak and scarcely able to bear their own weight if allowed to develop unhindered. With these, careful attention should be given during the first few years to producing a well balanced tree capable of carrying good crops of fruit.

The Mexican race usually shows a tendency to grow more stiffly erect than the others, and make stout rigid branches which are capable of bearing heavy crops. In order to keep some of these varieties from becoming too tall and slender, it is necessary to top them when young, perhaps pinching out the buds of the main branches later on to induce branching.

It is not desirable to have the crown so dense that light will not reach all parts freely. When the crown is too thick, fruit is produced only on its outer surface, and much of

the fruit bearing capacity of the tree is thus wasted.

Thus it can be seen that no specific rules for pruning, covering all varieties, can be laid down, other than that the object, should be to produce a tree having a broad, strong, well branched crown of good proportions and great fruiting capacity, preferably headed low (about 30 inches above the ground), in order to shade the soil beneath it. After the tree has reached maturity little pruning is required, provided it has had the benefit of careful training during the first few years. Experience along this line is meager, however, and the future will bring out many new points of importance.

In top-working old seedlings, it is often necessary to cut off large limbs. The stubs should be smoothed off and covered with a coating of grafting-wax. The same rule applies to cuts made in the course of ordinary pruning with young as well as old trees. When secondary branches are removed, they should be cut as close to their junction with the main branch as possible, and the cut should be parallel with the main branch. The cut surface should be treated with a coating of grafting wax. Paint is sometimes used for this purpose, but in Florida it has been found injurious, especially to young trees. If the stubs are not waxed, they often allow fungi to start and destroy the wood. The entrance of such fungi is facilitated by the fact that the pith sinks in the cut ends of large limbs, leaving a small cavity to collect water and maintain the moist conditions which are so favorable to fungous growth.

Opinions differ as to the best time for pruning. In Florida late fall and winter, November to February, have proved suitable. In California the best growers seem to favor spring or fall. According to Krome, pruning in hot weather often results in serious injury. The most favorable times seem to be early spring, before growth has commenced and before the heat of summer and autumn after hot weather is past.

PROPAGATION

Avocados do not come true from seed; that is, a tree grown from a seed of the Trapp variety will not produce Trapp fruits, although it may produce fruits similar in character. For commercial purposes it is necessary to propagate the trees by budding or grafting, in order to insure good fruit of uniform quality and to eliminate sparse bearers, or trees otherwise undesirable.

Seedling avocados are often grown, especially in the tropics. While named varieties cannot be propagated in this way, if the seed is taken from good fruit the tree which it produces is likely to bear such fruit. But occasionally seedling trees do not bear, and some have other undesirable qualities, so that it is always best to plant a budded tree. Seedlings can only be recommended, in fact, where a tree is desired for the dooryard merely, in which case the ornamental appearance of the avocado makes it eminently satisfactory. If such trees do not bear well no special loss is entailed.

Since 1901, when George B. Cellon first budded the avocado commercially, several methods of vegetative propagation have been applied to this plant by nurserymen. While all of these have been successful in the hands of certain propagators, shield-budding, which was originally used by Cellon, has proved the most generally

dependable, and is now employed by most nurserymen in California and Florida. It is, therefore, given major consideration here, while methods of grafting are described in less detail.

Stock plants.

In Florida it has been the custom to bud or graft West Indian varieties on seedlings of the same race. In California the Guatemalan race has usually been budded on the Mexican, in the belief that the superior hardiness of the latter would make the budded tree less susceptible to cold and also because seeds of the Mexican race are more easily obtainable. Recently in Florida the Guatemalan has been budded on the West Indian, the West Indian on the Mexican, and so on; and these experiments, although not extensive, have served to indicate that the question of stocks is of great importance, and demands further investigation. Not only does it appear that the hardiness of the tree may in a measure depend on the nature of the root stock, but the congeniality of the various races, when budded on each other, seems to differ. Attempts to bud the West Indian on the Mexican have produced rather indifferent results in Florida, the buds making a poor union and growing very slowly. The Mexican race has not been tried on the West Indian extensively, but this practice appears to succeed better than the reverse. The Guatemalan buds well on the West Indian, but is perhaps preferable on Guatemalan roots.

Seeds are usually obtainable most abundantly in August and September in Florida, a month or two later in California, having reference to the West Indian race in the former state and the Mexican in the latter. These two races are those generally used for seedling stocks. The seeds should be planted soon after removal from the fruit, although they are viable for several weeks if kept cool and dry. Seeds of the Mexican race have even been kept for three or four months in good condition, in the dry climate of California.

Previous to the issuing of Quarantine Order No. 12 of the Federal Horticultural Board, prohibiting the importation of avocado seeds from Mexico, many thousands were imported annually to California from that country. In shipping these, the best results were obtained when the seeds were removed from the fruit, washed immediately, dried in the shade, and packed loosely in wooden boxes without the addition of moistened sawdust, charcoal, sphagnum moss, or other material. The percentage of loss with such seeds was insignificant. When shipping seeds from moist tropical regions, greater difficulty is experienced, decay being more troublesome. Good results are sometimes secured by shipping in slightly dampened charcoal, but where the distance is not too great the best method seems to be to wash and dry the seeds and then pack them loosely in wooden boxes, as above described.

Seeds are planted in pots, boxes, flats, or in the open ground. For nursery work on a large scale, planting in flats and seedbeds has given excellent results. The seedlings are transplanted almost as soon as they have sprouted. In California seeds planted in the seed-bed during autumn, October to December will make plants six to twelve inches high by March or April, when they may be planted out in the field in nursery

rows.

While seedlings are sometimes budded in pots or boxes, field budding is more satisfactory, as it is difficult to bring pot-grown trees into the vigorous growth essential to success in budding.

Planting in the field should be done in California as soon as danger from frost and cold weather is past. Nursery rows should be 3 to 4 feet apart, with the plants 18 inches apart in the row (or about 12 inches in Florida). Partial shade should always be given the young plants for a few days after they are set in the open, especially if they have been sprouted, as they should be, under a lath- or slat-house. In Florida, seeds planted in August may be set out in the field in November, and should make trees ready to bud by January or February, which is the proper season for budding in that state.

For germinating seeds, a light, loose, sandy loam is preferable, pure sand sometimes being used in California if the seedlings are to be transplanted as soon as they have germinated. Four-inch pots are large enough for seeds of the Mexican race, but frequently a five or six-inch pot is necessary to accommodate the West Indian. In Florida, wooden boxes about 6 inches in each dimension are often used, while in California tin cans are employed, but the latter are much less desirable than clay pots. When planted in flats or seed-beds, the seeds may be placed close together. The pointed end of the seed, — or in the case of round seeds, the end which has been toward the stem in the fruit, — should be uppermost, and it is usually allowed to project above the surface of the soil, not more than four-fifths of the seed being below the surface. If the seed coats are loose and come off easily, it is well to remove them before planting.

The soil should be kept moist while the seeds are germinating. The time required for germination varies greatly, sprouts sometimes appearing within two weeks from planting, while in other instances they may be two or three months in starting. A month is the average time in warm weather.

Essential features of bud propagation.

Shield-budding is most successful when the stocks are small and full of vigor. If the plants are once allowed to cease the rapid thrifty growth with which they spring from the seed, the wood hardens, sap is less abundant, and if the bud unites at all there is great difficulty in forcing it into growth. Those who do not devote their undivided attention to the propagation of the avocado sometimes allow the seedlings to get into this condition before they attempt to bud them, and as a result failures are numerous. It must be stated unreservedly that shield-budding of the avocado, to be successful, must be made the subject of careful and intelligent study on the part of the nurseryman, who must exercise constant vigilance to keep the stock plants in perfect condition. If this is done, and budwood is intelligently selected, success is within reach, but the number of failures from neglect or ignorance of these two points might well be enough to discourage the beginner from attempting to bud the avocado. It is only through the closest application to minute details that real success in budding

avocados can be achieved, and it may truthfully be said that those who have produced budded trees in quantity have invariably been men who have devoted their best efforts to the work and made it a painstaking study.

Budding (Fig. 3).

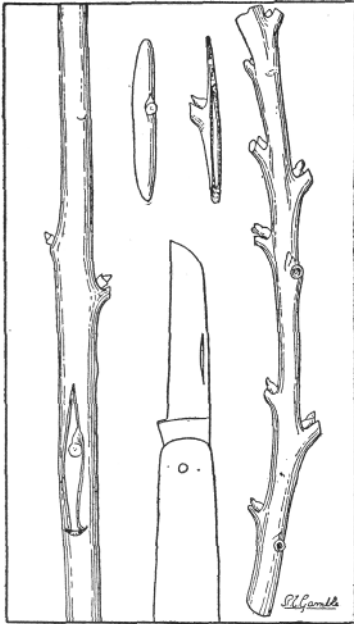


FIG. 3. Shield-budding the avocado. On the left, a bud properly inserted; above the knife blade, two buds of proper size and shape; and on the right, budwood with good "eyes." The method of wrapping the inserted bud is shown in Fig. 11.

As soon as the stock plants are large enough to receive the bud conveniently they should be budded, provided the season is favorable. In southern Florida the best months for budding the West Indian race are November, December, January, and February. Budding can be continued into March with success, but after warm weather commences the percentage of failures is too high to make the undertaking profitable. In California the best time is as soon as the sap has begun to flow freely. This usually occurs late in April or early in May, at which season there is a period of three or four weeks when budding is more successful than at any other time of the year. After this short period, however, avocados are in active growth and the proper sort of budwood is difficult to obtain, hence it is best to wait until the growth has hardened sufficiently to make good budwood. This will usually be late in June or in July, when budding can be recommenced and continued until autumn. October and November are good months, although not quite so favorable as the first-named period in the spring. Buds inserted in autumn frequently push out within five or six weeks and must be protected carefully during the

ensuing winter. Unless the work is done very late in the autumn, the buds cannot be held dormant until spring.

Selection of the proper type of budwood requires more experience and judgment than any other feature of avocado propagation, since the character of the buds differs widely among varieties of the same race. Some kinds make such poor budwood that not more than 50 per cent of the buds will grow even for the most skillful propagator; in other varieties, such as Taft and Fuerte, 95 per cent of the buds can frequently be made to develop into trees. In general, it may be said that the budwood should be of recent growth, not soft enough to snap on bending but beginning to mature. In early spring, budwood must be obtained from mature growth of the previous fall and early winter. In summer it must be obtained from the current season's growth. In some sorts, such as Fuerte, very young budwood can be used successfully, but that which has commenced to mature is usually better. Buds can sometimes be cut from the tips of the branchlets and from 6 to 12 inches from the tip, according to the variety and the condition of the wood. Buds which have broken into growth should be avoided, in the case of most varieties, at least; so should those from which the outer bud-scales have dropped, as this is indicative of old wood, and such buds, when inserted, will frequently "drop their eyes" and leave a blind shield from which a tree cannot develop.

To insert the buds, an incision is made in the stock, as close to the ground as convenient, either in the form of a T or an inverted T. No particular advantage seems to be derived from either form of incision, both being used quite successfully. The bark should not be opened by using the ivory end of the budding-knife, as this injures the delicate tissues below; if the bark does not separate from the wood readily enough to allow the bud to be pushed in easily, the stock is too dry to be budded. The propagator should always aim to have the stock plants in such vigorous condition that he can force the bud into the incision with very slight pressure and without loosening the bark with his knife. The most skillful budders, when making the horizontal cut of the incision, turn the knife blade forward dexterously, forcing the bark away from the stock and leaving a sufficient opening in which to insert the point of the bud. The latter is then pushed in very gently and wrapped immediately with a strip of waxed cloth, raffia, soft cotton twine, or plain tape. This should be wound firmly around the stock, from the bottom upward, and fastened securely at the upper end, above the incision, by slipping the end through the last loop and drawing it down tightly.

In cutting the buds, an extremely thin-bladed, sharp-edged budding-knife should be used, and it should never be allowed to become the least bit dull. A razor-strop is usually worn by budders, attached to the belt; after ten or fifteen buds have been cut, the knife is given a few strokes on the strop to keep it in perfect condition. It should be the aim of the budder to cut the bud with one sliding stroke of the knife, keeping the blade as nearly parallel with the budstick as possible, so that the cut surface will be flat and not rounded at the ends. Buds which are gouged out do not fit snugly on the stock. It is well to cut the buds somewhat larger than citrus buds, 1 inch being the minimum length, and 1½ inches the ideal for most varieties. This must vary, of course, with the size of the stock and budwood, large stocks sometimes taking a bud 2 inches long.

Opinions differ as to the best material for wrapping, some preferring waxed cloth, while others have found plain cloth tape equally good, and still others use raffia successfully. Waxed cloth is doubtless the safest, but the objection to it has been that in hot weather the wax melts and works its way into the bud, sometimes killing it. This can be avoided by using a compound of 1 pound beeswax and ¼ pound rosin. The cloth, preferably a cheap grade of bleached muslin, should be torn in strips 6 inches wide, made into rolls 1 inch in diameter, and boiled for fifteen minutes in this mixture. It may then be kept until needed, when it is torn into narrow strips of the proper width and length for tying buds.

Three weeks after insertion the buds should have united with the stock and the wraps must be loosened or they will soon bind the stock, if growth is active. They should not be removed until the end of six weeks or two months. In order to force the bud into growth, the tree should be topped at the time the wrap is first loosened, 3 or 4 inches being removed from the tip. The axillary buds along the stem will then break into growth; some of these should be allowed to develop for a while, to keep up an active flow of sap. In another four or five weeks the top should be cut back farther, but a few axillary buds still left on the seedling to grow and maintain the flow of sap. If the stock is cut back too heavily the first time, the eye may fall from the bud, leaving a

blind shield. Lopping, as practiced with many other fruits, is not altogether successful with the avocado.

As soon as the bud has made a growth of 3 or 4 inches, it should be tied back to the stem of the seedling with raffia. Later it must be stake-trained, and when it has reached a height of 24 to 30 inches it should be forced to branch and form a shapely top. The stub which remains from the seedling stock should not be cut off until the bud has developed to the height of one foot. In California it is usually considered best to remove the stub in winter; it should be cut off just above the bud, and the cut surface covered with grafting-wax, or shellac made with alcohol and a little rosin. Common paint should not be used for this purpose.

Field-grown trees, after they have reached the proper size, are either lifted and put into pots or boxes, where they are held until established and then planted in the field; or they are balled at any time after they have gone dormant in late winter, and heeled-in under a plant-shed, where they can be kept until spring and then planted out. In Florida, field-grown plants are usually lifted and set in wooden boxes 5 X 5 X 12 inches in size. As soon as they are placed in these boxes, they must be set in partial shade and watered copiously. When they have become established, which will be within a month or six weeks, they can be transplanted to the orchard.

Transplanting with bare roots has not proved generally satisfactory in California. Regarding his experience with it in Florida, Krome says:

"This may become one of the recognized methods of planting and under certain conditions it has many advantages over setting either boxed or balled plants. Two years ago I moved about four hundred seedlings with semi-bare roots and lost only three trees in the process. The trees were two year stocks averaging four feet in height grown in a 'red-flat' at my own grove. We began transplanting during July but most of the trees were moved in September. We waited until the trees had reached a dormant state between flushes and then defoliated them and pruned back the tenderest growth. We moved them only after three o'clock in the afternoon when the greatest heat of the day was over, digging only as many trees as could be carefully planted during the remainder of that day. Before digging we wet down the surrounding soil until it puddled easily. The trees were dug with as much of the root systems as could well be handled and the roots were immediately wrapped in wet burlap and the trees placed in the shade. We did our defoliating and pruning back considerably ahead of the digging and found that trees which had been cut back for a week or more and had just started a new growth could be moved as successfully, and in fact grew off better, than those which had been more recently defoliated.

"Since then we have carried on experiments in this line at our nursery, using trees with roots entirely bare, and have had a very low percentage of loss. Upon our recommendation a number of avocado growers in South Dade have tried the method with a limited number of trees and without exception have expressed themselves as intending to make all their plantings hereafter with bare-root trees.

"The two essentials seem to be getting the tree into proper condition before moving from its original position and plenty of water after transplanting."

Grafting.

One method of grafting has been employed extensively for the production of nursery stock in Florida, and another has been used on a limited scale for top-working old trees.

The system extensively used is a modified form of the side graft employed with other plants. The seeds are germinated in a seed-bed; when the sprouts have reached a height, of 5 or 6 inches the plants are dug and laid on the bench. A cut an inch long is made on one side of the sprout, just above the seed, and a thin section of the stem removed, exposing the tissues. The scion is then taken from the tip of a very small branchlet, preferably one which has not fully matured. It should be about 1 inch long, and provided with one or two axillary buds as well as the terminal. It is trimmed on one side to a tapering point at the lower end, and this cut surface is placed against the cut on the stock, after which it is bound carefully in place. The plant is then potted, placed under partial shade, and carefully watered from day to day. After a union is effected, the top of the seedling is removed and the scion allowed to develop.

Top-working old trees.

Large numbers of seedling avocados have been planted in Florida and California. Many of these produce fruits inferior in quality to the best budded varieties, while quite a number do not produce at all. It is often desired, therefore, to convert such avocados into budded trees of choice varieties, and this can easily be done.

Several methods of top-working are employed, the most satisfactory one being shield-budding. When trees are to be top-worked by this means, they should be cut back in November or December in Florida, February or March in California, removing three-fourths of the main limbs a foot or two from their union with the trunk, the remainder being left to keep the tree in vigorous condition. The limbs should be cut off with a sharp saw, to avoid splitting or tearing on the lower side. The stubs should be covered with a good coating of grafting-wax.

When growth has commenced, in early spring, numerous sprouts will appear around the upper ends of the stubs. Only three or four of the strongest should be allowed to remain on each stub, and when these have reached the diameter of one's little finger, they may be budded in the same manner as seedlings, with a large bud, preferably from growth which is not mature. The exceedingly vigorous growth of these sprouts makes success much more certain than in budding seedlings in the nursery. Because of the rapid growth, it is necessary to loosen the wraps frequently to keep them from binding. They should not be removed entirely before the buds have developed to a length of 6 or 8 inches. The sprouts rising from the upper side of the stub form stronger unions with the latter than do those from the lower side. Cleft-grafting, another method employed in top-working old trees, is most successful with seedlings two to four years old, but can also be used on older trees. While it has not been practiced extensively, it has given good results in the grove of W. J. Krome, at Homestead, Florida. Krome has worked out the method here described.

The trees to be grafted should be sawed off 2 to 4 feet from the ground, according to size, this work being done during November and December in Florida, though it has been successful as late as March. With two-year-old seedlings the trunk itself is sawed off; on larger trees it is well to go above the trunk and saw off the main branches a foot from their union with the trunk. A cleft is then prepared in the stump, not by splitting it with a grafting tool as is usually done with fruit trees in the North, but by using a saw. After sawing to a depth of 4 to 8 inches, depending on the size of the stub, the saw is removed and a soft wooden wedge is inserted in the top of the cleft and driven down until the lower end of the cleft begins to split. This produces the steady pressure necessary to hold the scion firmly in place.

Scions are cut from wood of larger size and more mature growth than is used for budding, branches about $\frac{1}{2}$ inch in diameter being preferable. The scion, which should be 6 to 9 inches long, is trimmed on two sides throughout the lower half to a slender tapering point at the bottom. It is then placed in position in the cleft and forced downward until the upper end of the cut surface is flush with the top of the stub. One scion is placed in the cleft at each side of the stub, nearly even with the surface of the bark on the outside. The wedge which has been used to keep the cleft open is now partly withdrawn until the scions are clamped firmly by the pressure of the two halves of the stub, when it is sawed off flush with the top of the stub and allowed to remain in place so that the pressure on the scions will not become too great.

After the scions are properly placed, the cleft is filled with plastic grafting-wax so that air is excluded. Wax is also rubbed over the outside of the scion where it fits into the stub. The stub is then firmly wound with strips of waxed cloth, covering the top as well as the sides. A collar made of builder's paper is then tied around the stub, extending an inch above the tops of the scions. This collar is filled with sand. Particular attention must be given to insuring a layer of sand between the scions and the side of the collar, since otherwise the latter transmits heat from the outside and kills the scions. Vent holes should be made in the paper near the top of the stub to drain off the water which collects within the cup.

Nothing more remains to be done until the scions have had time to unite with the stock. Two or three months after growth has commenced the sand may be removed and the collar taken off. As a rule, only the stronger of the two scions develops. Both may start to grow but one eventually outstrips the other in most cases, and the weaker one succumbs.

This method appears to produce vigorous trees. Its use has been attended by excellent results at Homestead.

THE CROP

The age at which budded avocado trees come into bearing varies with the different races, and also among the varieties of the same race. Furthermore, experience indicates that many kinds will bear at an earlier age on the sandy soils of southern Florida than on the heavier lands of California. In the latter state, budded trees of the Mexican race frequently come into bearing the second or third year after they are planted in the orchard; the Guatemalan race shows greater range among the

numerous varieties, some, for example the Lyon, commencing to bear within eighteen months or two years from the time of budding, while others, for example Taft, have not borne earlier than the fourth or fifth year. Trapp and several others West Indian varieties have been grown for four or five years in southern California without bearing fruit. They are sometimes injured by cold, but, allowing for setbacks from this cause, the West Indian race does not fruit so early in California as in Florida. The Mexican race usually fruits at an early age in both regions.

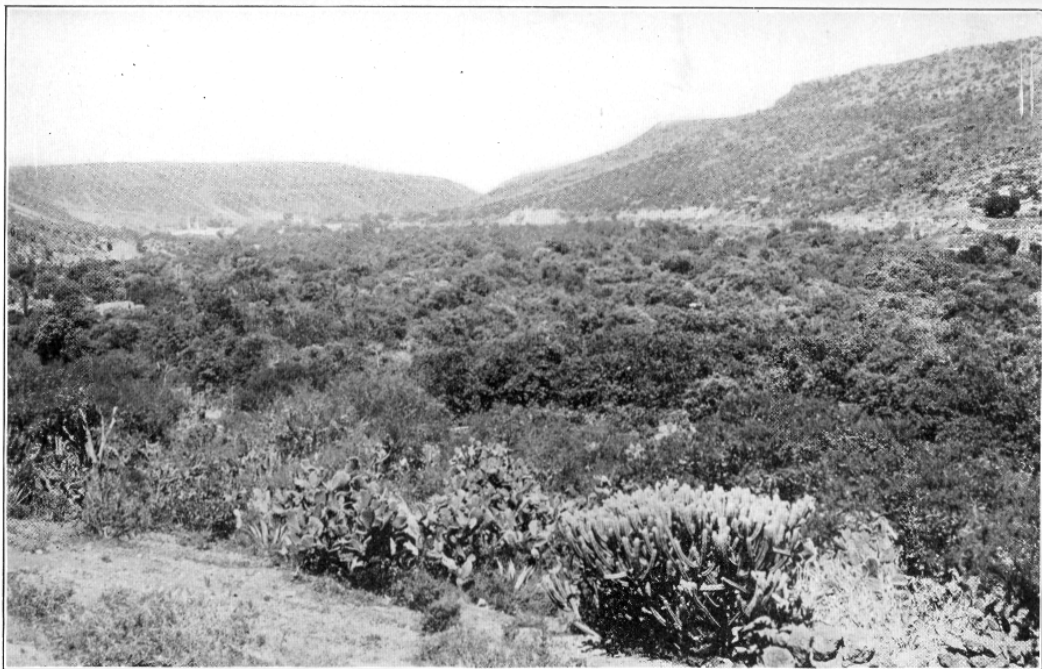


PLATE III. Avocado-growing in the Mexican highlands.

As a rule, budded trees of the West Indian race are precocious in Florida. Trapp is remarkable in this respect; and in addition it has a strong tendency toward over-production which must be checked during the first few years by thinning the fruit. Trapp trees will often produce a few fruits the year after they are planted in the orchard and at three years from planting may begin to yield commercial crops. If grown under irrigation, so that their development has been rapid, the trees may be allowed to carry thirty or forty fruits the third year after planting, but during the first year it is best to remove all fruits, and the second year not more than half a dozen should be allowed to mature. When grown without irrigation, the tree is rarely large enough at three years of age to carry more than twelve or eighteen fruits without injury to itself, unless soil conditions have been very favorable. The mistake is often made of allowing Trapps to over-bear when young, with the result that they die back following the fruiting season.

Seedlings vary even more than budded trees in the age at which they begin fruiting. The Mexican race often fruits at two or three years from seed. The Guatemalan race, in California, has occasionally fruited at three or four years, but more commonly comes into bearing at six or seven years. The West Indian race, in Florida, does not

usually come into bearing earlier than five or six years from seed.

In California, no figures showing the yield of a budded orchard have as yet been obtained, but in Florida, where the avocado industry is older, interesting data are available. While the figures given may not apply to both regions and will certainly vary greatly with different sorts, they serve at least to show what may be expected from one variety under certain conditions.

According to George B. Cellon, a Trapp tree seven to ten years old will yield, under good cultural treatment, between five and ten crates of fruit, counting forty fruits to the crate, which is about the average pack. The returns from one of the largest groves near Miami for two seasons, however, show an average of only one and one-half crate to a tree. This is a low yield, and should certainly be exceeded. Krome, who has kept careful crop records, finds that his Trapp trees at five years of age yield one to four crates a tree, two and a half crates being the average. Charles Montgomery of Buena Vista, Florida, has obtained yields of about the same amount, his estimate being that a mature Trapp grove should produce 500 crates to the acre.

The yield of other varieties in Florida is not so well known, since none except Pollock has been planted to any extent, and even this variety is grown in comparatively small numbers. In regularity of bearing Trapp excels Pollock, the latter showing a tendency to fruit in alternate years.

In Guatemala and Mexico, many seedling trees of the Guatemalan race tend to produce good crops only in alternate years. The feature is not so marked in trees of the West Indian race which have been observed, nor in those of the Mexican; nor is it true that all Guatemalans possess it. It is possible that over-production one season results in a crop failure the following one, and it is probable that unfavorable cultural conditions have something to do with the matter.

SEASON

The season during which avocados are obtainable in southern Florida has been, until very recently, from July until January. A few Trapps may hang on until February or even as late as March, but the fruit is so scarce after the early part of January that it need scarcely be reckoned with. The earliest varieties of the West Indian race begin to ripen in July, while the bulk of the seedling crop matures in August and September. During this season avocados are cheap, and the markets of the North are receiving shipments from Cuba, but there is a certain demand for high-class fruit even during the summer, and such varieties as Pollock are profitably grown in a small way. It has always been recognized, however, that the most profitable avocados are those which can be marketed in winter, for not only is the cheap seedling fruit out of the way at that time, but the markets of the North are not filled to overflowing with peaches, plums, grapes, and other standard fruits.

It is, therefore, the late Trapps which have been the most profitable in Florida, and the constant search has been for even later varieties which would make it possible to supply the markets during late winter and early spring. Such have not been found

among those of the West Indian race, but the Guatemalan meets this demand, and varieties of this race will, in all probability, soon be planted extensively in Florida. The Guatemalan kinds which have already fruited at Miami and elsewhere have served to indicate that the season during which this race will ripen is, roughly speaking, November to May.

In California a given variety of the Guatemalan race ripens one to two months later than in Florida, so far as present experience goes. The season of this race in California extends from January or February, when the earliest sorts appear in the market, to autumn. Following the Guatemalans, the Mexican varieties mature, their season in general being October to January, although there are some kinds which mature a few fruits in spring. Thus it can be said that there is never a day when ripe avocados are not obtainable in California.

While the Mexican race has received little attention in Florida, it seems likely to become of considerable value for the cooler sections of the state, now that varieties of good size and quality are obtainable. Chappelow has been in bearing at Miami for some years, maturing there in June and July, which is considerably earlier than in California.

In Cuba it is said that trees growing on dry soils will hold their fruits longer than those growing on low moist land. Occasional seedling trees (West Indian race) are found throughout Cuba which have the reputation of carrying their fruits until Christmas or even later. Such trees are, of course, highly profitable to their owners, since avocados are in great demand in Havana during the winter months, and the supply at present is limited.

PICKING, PACKING, AND MARKETING

Avocados are picked best with orange clippers. The stem is usually swollen just above the point of attachment with the fruit; it should be severed with the clippers immediately above this swollen portion. In order to supply the early markets, avocados are sometimes picked before they are fully mature, a custom which should be discouraged. Immature fruits are certain to be inferior in flavor, and should they fall into the hands of those who were trying the avocado for the first time they would be certain to give a bad impression. Trapps are usually left on the tree as long as possible, in order to obtain the high prices which late fruit commands; when they begin to change from bright green to yellowish green they must be picked or they will drop. If they are picked only a day or two before they would drop, they are sure to ripen in transit and reach the market in an over-ripe condition. To prevent this, Cellon advises that questionable fruits be laid aside for twenty-four hours; if at the end of this time they are still firm, they may safely be packed for shipment. The standard package for avocados in southern Florida is the tomato crate, which measures about 12 X 12 X 24 inches. It is sometimes used with a partition in the center, sometimes without. Excelsior is placed above and below each layer of fruits as a cushion, and is stuffed around them freely to hold them in place and prevent bruising. Some growers wrap each fruit in tissue-paper, but the wisdom of this practice is doubtful. The fruits heat more quickly when wrapped, and as heating greatly

hastens the ripening process it should be avoided as much as possible. Avocados must not be packed under such great pressure as oranges, more care being necessary in nailing on the top of the crate to avoid crushing the fruits.

The number of fruits to a crate varies from twenty-three to fifty-four with Trapp, the average being about forty. Pollocks run from eighteen to thirty-six to a crate, while seedlings run from twenty-eight to ninety. Quotations, f. o. b. southern Florida, are sometimes made by crate, sometimes by dozen fruits. The following figures on Trapps are those quoted by one of the principal shippers at Miami during the past several years:

First week in October, 54s (that is, fruits which pack 54 to the crate), 75 cents a dozen; 50s, 85 cents; 46s, \$1; 36s, \$1.30; 28s, \$1.75; 23s, \$2. After November first the price is increased on all sizes, as follows: 50s, \$1.50 a dozen; 46s, \$2; 36s, \$3. At Thanksgiving the prices vary from \$3 to \$4 a dozen for 24s, 36s, and 46s, and about Christmas they advance to \$4 to \$6 a dozen.

Pollock's are quoted during August as follows: 36s, 75 cents a dozen; 28s, \$1; 24s, \$1.50; 18s, \$2. The quotations on high-grade seedling fruits at the same time are as follows: 50s to 60s, 60 cents a dozen; 46s, 75 cents; 36s, \$1; 28s, \$1.50.

Prices on Trapps a crate vary from about \$2 in early October to as high as \$36 for the last few crates at the end of the season in February; these figures are f. o. b. southern Florida. From one of the principal groves near Miami the entire crop has been marketed for several years at an average net price of \$5.25 a crate averaging forty fruits. The average return from 1400 crates shipped from another grove was \$5.50 a crate.

Trapps have been shipped from southern Florida to all parts of the United States. A few years ago one grower sent small consignments every day during a large part of the season to Seattle, Washington, and did not receive a complaint of a crate received in bad order. These shipments were on the road eight days, and were not sent in cold storage. It is the general practice to ship from Florida by express. The shipping qualities of Trapp are much better than those of the average seedling.

At present most of the Florida Trapp crop goes to the markets of the eastern United States, Washington, Philadelphia, New York, and Boston each taking a good share. Some growers have shipped heavily to Chicago and other points in the Middle West, and small shipments go to the Pacific Coast each year.

The production in California has not yet become great enough to permit of commercial shipments to eastern markets, the crop being consumed locally. Since most of the returns up to the present time are based on the crop from the parent seedling tree of each variety, they are of little value to show the probable profits from a budded orchard of the same sort. The most remarkable record which has been made by a commercial planting of budded trees is that of J. T. Whedon at Yorba Linda. Whedon's planting of the Fuerte variety, containing fifty trees (less than one acre), produced a crop of fruit when five years old which sold for \$1700.

PESTS AND DISEASES

In the early stages of many horticultural industries insect pests and fungous diseases are not troublesome, but as the industry develops its enemies become more numerous. So it has been with the avocado. During the first few years in which this fruit was planted commercially in Florida little injury was caused by parasites, but recently it has been necessary to combat vigorously the insects which prey on the tree, and also several fungous diseases.

In California the avocado has, up to the present, been comparatively free from the attacks of insect and fungous pests; yet several insects have made their appearance in the orchards and must be watched carefully lest they become so numerous as to cause serious harm.

Thrips and red-spider are the most common insects which attack the avocado in Florida. Red-banded thrips (*Heliothrips rubrocinctus* Giard.) and the greenhouse thrips (*Heliothrips hæmorrhoidalis* Bouché) feed on the foliage, sometimes causing much damage. Both these species are exceedingly small, soft-bodied, fringed-winged insects, with piercing mouth-parts by means of which they puncture the epidermis and extract the juices from the leaves. They are most destructive in early spring, their numbers being greatly reduced when the summer rains commence. Spraying with nicotine solutions has been quite effective in controlling them.

The red-spider (*Tetranychus mytilaspidis* Riley) also does considerable damage during the spring months. This insect, which is scarcely larger than a pin point, can be detected on the foliage without the aid of a magnifying glass because of its bright red color. It feeds on the avocado by piercing the leaf tissues and extracting the plant juices. Often it becomes so abundant as to cause the leaves to assume a brownish, sickly appearance. It occurs commonly in California as well as in Florida, but has not yet been reported as attacking avocados in California. Lime-sulfur mixtures have been used successfully in combating this insect. For citrus trees, H. L. Quayle recommends commercial lime-sulfur, dry sulfur and hydrated lime, and distillate emulsion. These may all prove to be effective with the avocado as well.

Among the scale insects which commonly attack the avocado, the most important are the black scale (*Saissetia oleæ* Bern.), and a soft white scale (*Pulvinaria pyriformis* Ckll.), the latter being a serious pest in Florida. Severe infestations of the black scale are occasionally found on old seedling trees in California, but this insect has not yet become a pest in the young avocado groves of that state. The wax scale (*Ceroplastes floridensis* Comst.) is occasionally found on avocados in Florida, but rarely requires combative measures. All of these scale insects, as well as a white fly (*Trialeurodes floridensis* Quaint.), which has become troublesome on some of the Florida Keys, can probably be controlled by the use of oil sprays.

The citrus mealy-bug (*Pseudococcus citri* Risso) has been reported on the avocado in Ventura County, California, but it is not known to have caused extensive damage. The avocado mealy-bug (*Pseudococcus nipæ* Mask.), which is a serious pest in Hawaii, has been found in southern Florida groves. It sometimes becomes very troublesome. D. F. Fullaway of Hawaii recommends that it be controlled by spraying with oil-emulsions.

The presence of the avocado weevil (*Heilipus lauri* Boh.) in California, where it was probably introduced from Mexico in avocado seeds, caused the Federal Horticultural Board to prohibit the importation of seeds of the Mexican race from Mexico and Central America. This insect is a small black beetle which tunnels in the seeds, and is said to do considerable damage.

Other seed weevils attack the avocado in various parts of the tropics. H. S. Barber describes the more important ones, so far as they are known, in the Proceedings of the Entomological Society of Washington, March, 1919. *Heilipus pittieri* Barber, from Costa Rica, is similar to *H. lauri*. *Conotrachelus perseae* Barber does great damage to avocados in Guatemala. Its larvae have been found in avocado seeds sent to the United States, but it is believed the species has not become established in this country. Once thoroughly established, the seed weevils are difficult to exterminate, hence it is to be hoped that they will not gain a foothold in this country.

In Guatemala, *Trioza koebelei* Kirkaldy (and perhaps other species) produces leaf-galls on the avocado, often in such great numbers as seriously to affect the health of the tree.

In addition to these insects, a number of others have been reported as attacking the avocado in various parts of the tropics. These include numerous scale insects, both armored and unarmored, several borers, and the well-known Mediterranean fruit-fly (*Ceratitis capitata* Wied.); the better-known species are listed in the Manual of Dangerous Insects published by the Department of Agriculture.

In the dry climate of California, fungous parasites give the avocado grower comparatively little trouble, but in Florida and in many parts of the tropics they may require stringent combative measures.

The following extracts from a paper by H. E. Stevens, published in the Proceedings of the Florida State Horticultural Society for 1918, cover the situation as regards fungous pests in Florida as it exists at the present time:

"Leaves and frequently fruits of the avocado are attacked by a fungus which is probably a species of *Gloeosporium*. The affected leaf is usually attacked at the tip, and the disease gradually spreads until the greater part of the blade is involved, when the leaf falls. Severe attacks may cause considerable defoliation of trees and result in the death of young terminal twigs. Fruits may be attacked when small, in which case severe shedding may follow. If the more mature fruits are attacked, a brown spotting is produced and the skin may crack.

"Another common type of injury, frequently noted on the fruits, is referred to as anthracnose by some of the growers. This type of injury is very similar to melanose of citrus fruits in general appearance. It is superficial and appears in the form of dark reddish brown caked masses on the surface of affected fruits. The markings are hard, compact, and the surface is cracked or broken. The injury may cover only a part or the whole surface of the fruit. It makes an unsightly fruit, but apparently does not affect the quality. The disease is apparently caused by a fungus, perhaps a *Gloeosporium* or a closely related species.

"Another fungus, a species of *Colletotrichum*, is often observed in diseased spots on leaves and fruits. This fungus is closely related to *Gloeosporium* and the injuries with

which it is associated resemble those caused by the latter fungus. It is probably the cause of some of the injuries that are classed as anthracnose.

"In the control of these leaf and fruit spots, Bordeaux mixture has given satisfactory results where applied in time. As soon as the injuries begin to appear, spraying should be made and continued until the disease is checked. Two or three applications may be necessary, made at intervals of two or three weeks. If the fruit is near maturity, it is advisable to substitute ammoniacal solution of copper carbonate for the Bordeaux mixture, to prevent any disagreeable stain that may result from the use of the latter. Aside from spraying, all dead wood should be kept out of the trees, as this is likely to harbor these fungi from one season to the next.

"Avocado scab is of more than ordinary interest, owing to its close connection with citrus scab, and the fact that it has come into existence within the past three or four years. It is in all respects a new disease that has had its beginning in Florida.

"Scab is chiefly a disease of the tender growth, and at present it is found more abundantly in the nurseries, where it is particularly severe on seedling plants. It also attacks budded varieties in the nursery. The disease has been found on young and old bearing trees in the groves, affecting the leaves, and in a few cases the injury was observed on fruits. At present it is more common in the nurseries, but it may soon prove a serious pest in the groves.

"Scab forms definite spots or patches on the young, tender leaves and shoots, and severe attacks may cause the foliage to curl or become distorted. The more mature leaf tissue is not affected, but old leaves will be found bearing spots that were formed when the tissue was young. The spots are usually small, raised, circular to irregular, purplish brown to dark in color, and may vary from a sixteenth to an eighth of an inch in diameter. They may appear scattered over the surface, or several may grow together, forming irregular patches. The spots penetrate the leaf tissue, and they are visible on both sides. They are usually more prominent on the upper surface of the leaf, in which case the under surface of the spot will be slightly bulged and marked by a discolored area. The centers of the spots are composed of dead cells, more or less spongy in character and brownish in color.

In the earlier stages the surfaces may show a fuzzy, whitish growth — the fruiting parts of the fungus. The surfaces of older spots are darker in color and frequently covered with a dark webby fungous growth. On young shoots and twigs the spots appear more elevated, small, oval, dark purplish brown to black, and have comparatively smooth surfaces. This same type of spot is observed on the fruits.

"It is plainly evident that the avocado scab fungus is none other than *Cladosporium citri*, which causes citrus scab. The two fungi agree in structure and growth habits, and both are parasitic on citrus.

"Only tentative control measures for avocado scab can be suggested at the present time. Spraying with Bordeaux mixture for the disease in the nursery has given good results in some cases, in others less satisfactory. If the new growth can be protected while it is putting out, the disease may largely be avoided. The sprayings should be made when the foliage begins to put out, and continued until the leaves are nearly developed. The 4-4-50 Bordeaux mixture may be applied at intervals of ten days or two weeks, or often enough to keep the young foliage well protected. The fungus develops more rapidly during cool weather where moist conditions are provided. Shade and a crowded condition of the trees also seem to favor the development of the scab."

Many growers in southern Florida who have planted the Trapp avocado have been troubled by the trees dying back following the production of a heavy crop of fruit. Krome of Homestead has given this subject much study, and writes as follows regarding it in the 1916 Report of the California Avocado Association:

"Avocado trees of the West Indian race, when in good condition of growth, are prone to put on a tremendous bloom from which a setting of fruit is apt to result so heavy as to be entirely beyond the carrying capacity of the tree. Following this abnormal effort there is often a period of apparent exhaustion during which the tree seems to realize that it has 'bitten off more than it can chew,' and to be seeking the best method to recoup from its over exertion. This is a critical time in the life history of the tree and calls for intelligent handling on the part of the grower. If left to its own devices the tree will endeavor to carry the over crop, draining upon its reserves until its vitality has been seriously impaired. Evidences of this condition are usually very apparent. The tree drops a large portion of its leaves, the younger branches change in color from a dark green to a saffron yellow and no new growth is put on. Lack of sufficient foliage to provide proper shade often results in serious sunburning of the more tender branches, and the low state of vitality lays the tree particularly liable to the inroads of disease, especially of the anthracnose fungus which seldom loses such an opportunity for making an attack. Finally the tree is compelled to drop practically its entire crop of fruit and is left in a condition which means, at the very best, a set-back of two seasons in its development and not infrequently results in its actual death.

"To obviate over blooming, particularly in the case of young trees, is very difficult, for the better the cultural condition of the tree, the more likely this is to occur. The usual procedure has been to thin the over crop of fruit and this method of handling works quite satisfactorily provided the set-back to the tree has not already been brought about through the excessive bloom. However, the avocado requires a longer period than most fruits between the first appearance of the bloom and the setting of the fruit and it often happens that the damage to the tree has made considerable advance before relief by stripping can be obtained. In this event removal of the entire crop and further careful attention is necessary.

"In an effort to overcome this difficulty, I have during the past two seasons resorted to frequent applications of fertilizer, in order to offset the heavy drain upon the vitality of the trees during the blooming period. In the spring of 1916, following a season favorable to growth, the avocado trees at Medora Grove began to bloom about the middle of March. Immediately afterward a light application of fertilizer, carrying ammoniates from readily available sources was made. The bloom was the heaviest known in a number of years and persisted until about the middle of April. Between April 15th and 20th, another light application of the same fertilizer was made and this was followed by a third application the latter part of May, when a fertilizer somewhat higher in phosphoric acid, largely derived from low grade tankage, was used. As a result of this treatment a full crop of fruit was set and in most cases carried through to maturity without damage to the trees. When an over crop was set at first, as a rule dropping took place without a reduction in vitality, until the proper carrying capacity had been reached, and the remainder of the crop was matured. In a few cases stripping was necessary, but among nearly two thousand trees of varying ages, not more than eight or ten showed any appreciable damage."

In both California and Florida, avocados sometimes crack open while hanging on the tree. This has occurred in varieties of the Guatemalan and Mexican races, but is

most common in the latter. The cracks are usually situated towards the apex of the fruit, and are often very extensive. W. R. Home, H. S. Fawcett, and others have noted the presence of several fungi in the cracks and the flesh beneath them, but up to the present it is believed that these fungi are secondary, and not the cause of cracking.

RACES AND VARIETIES

The avocados cultivated in the United States are classified horticulturally in three races: the West Indian, the Guatemalan, and the Mexican. The West Indian and Guatemalan races, so far as can be judged at present, are two expressions of one botanical species, *Persea americana*, while the Mexican race represents a distinct species, *Persea drymifolia*.

Horticultural varieties of the avocado, when propagated from seed, do not reproduce the parent fruit in every detail. Seedlings from a round green fruit of the West Indian race may produce fruits oblong or pyriform in shape, and red or purple in color, varying from the parent in numerous other ways as well. But these seedlings will always be like their parents in certain respects, because they belong to the same race and will reproduce the racial even though not the individual characteristics.

To use the definition of H. J. Webber⁴, "Races are groups of cultivated plants that have well-marked differentiating characters, and propagate true to seed except for simple fluctuating variations." Technically speaking, the Mexican avocados should not be called a race, since they really represent a species; the West Indian and the Guatemalan, however, do not appear to differ from each other except in minor characters.

The classification of avocados into these three races has been useful, inasmuch as it brings together all those varieties which have several characteristics in common. In fact, the mere statement that an avocado belongs to the West Indian, Guatemalan, or Mexican race gives one an idea of the relative hardness, season of ripening, and commercial character of the fruit. The botanical standing of the cultivated races, as at present understood, and the characters which serve to distinguish them horticulturally, are shown in the following key:

1. Leaves anise-scented; skin of fruit thin (rarely more than 1/32 inch in thickness)
Persea drymifolia
MEXICAN RACE of horticulture
2. Leaves not anise-scented; skin of fruit thicker (from 1/32 to 1/4 inch in thickness)
Persea americana
 - a. Fruit summer and fall ripening; skin usually not more than 1/16 inch thick, leathery in texture.
WEST INDIAN RACE
 - b. Fruit winter and spring ripening; skin 1/16 to 1/4 inch thick, woody in texture.
GUATEMALAN RACE

⁴ In the Standard Cyclopedia of Horticulture

One variety cultivated in the United States, the Fuerte, appears to be a hybrid between the Mexican and Guatemalan races. Others of similar origin are likely to appear at any time; hence it is desirable to establish a group to include hybrids.

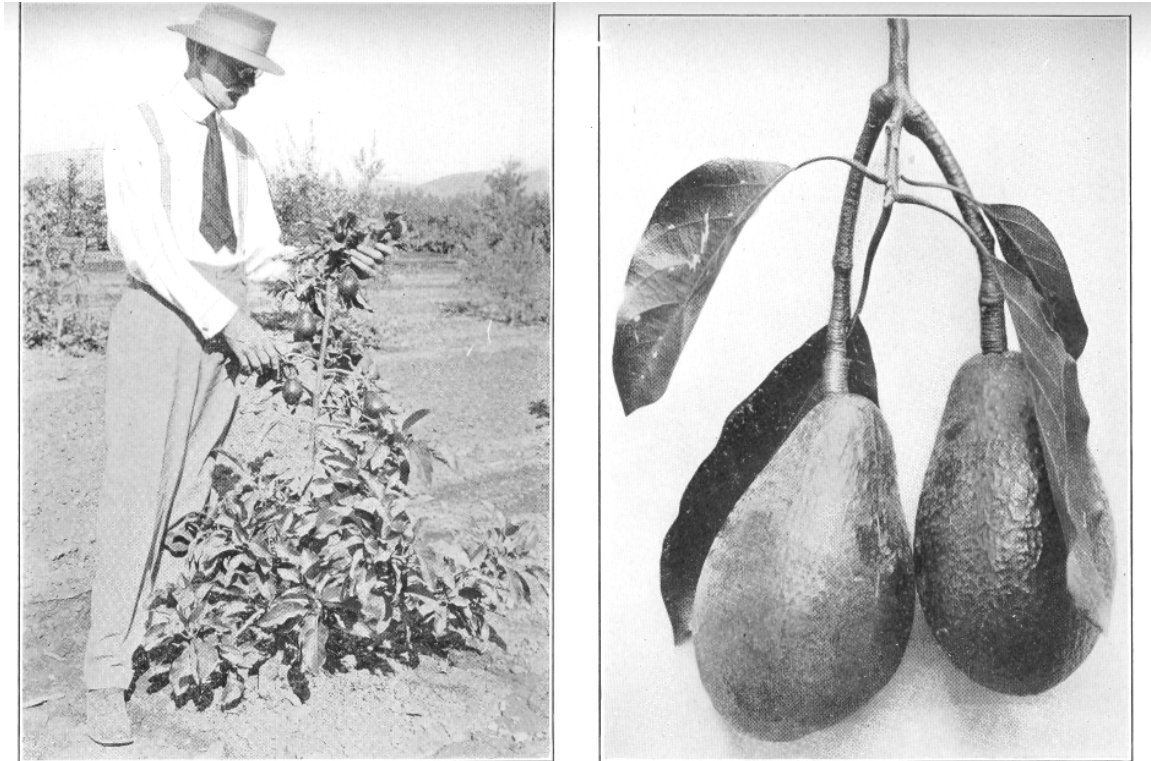


PLATE IV. *Left*, Puebla avocado tree producing its first crop at two years of age; *right*, the Fuerte avocado.

The avocados of the West Indian race have been developed in the tropical lowlands; the Guatemalan race, on the other hand, is a product of the highlands. At intermediate elevations varieties appear which belong to neither of these races, but possess some of the characters of each. These intermediate forms cannot be classified with accuracy.

In selecting varieties for commercial planting, it must be borne in mind, first of all, that the tree must be vigorous and hardy enough to grow successfully in the particular location which the planter has in view. Secondly, it must in time produce sufficiently large crops of marketable fruit to make its culture commercially profitable. It is not necessary that it be very precocious; it is noticeable, in fact, that precocious varieties often fail to make vigorous trees. It is more desirable to have the tree devote itself during the first three years to the development of an extensive root-system and a well branched crown capable of withstanding the drain imposed by the production of heavy crops of fruit than to have its growth limited and its vitality exhausted by premature fruiting. Thirdly, the fruit itself must be given consideration from a commercial standpoint. Attractiveness, flavor, shipping qualities, season, and other important characteristics should be considered in respect to the market it is proposed to supply. Naturally, good shipping quality can be sacrificed to some other

point if the fruit is for local use, while it is essential if the fruit is destined for distant markets. The flavor and quality of the flesh should be as good as possible, and the seed should not be unduly large.

More than one hundred and fifty varieties have been propagated in the United States up to the present time. The larger part of these originated as seedlings in California and Florida; the remainders have been introduced from Mexico, Guatemala, Cuba, the Bahamas, Hawaii, and a few other regions.

Of this large number not more than a dozen are likely to be planted ten years hence. Indeed, most of them have already been discarded. New varieties are originating every year, however, and the introduction of promising sorts from foreign countries is receiving much attention. It is only by testing a large number of varieties from all of the important avocado regions of the tropics that the best available kinds for commercial cultivation can be obtained.

It is not desirable to burden such a work as this with descriptions of all the avocados which have been propagated. It is sufficient to include the more important ones which are at the present time being planted commercially. For descriptions of minor varieties, and for information regarding the behavior and value of new introductions, the reader is referred to the annual reports of the California Avocado Association. In 1917 this organization issued Circular No. 1, "Avocado Varieties Recommended for Planting in California," the suggestions contained in which have done much to eliminate from consideration numerous inferior sorts. The varieties recommended in this circular are as follows, the arrangement being according to season of ripening in California:

Spring varieties

Fuerte, Spinks, Blakeman, and Lyon

Summer varieties

Spinks, Blakeman, Lyon, Dickinson, and Taft

Fall varieties

Taft, Dickinson, and Sharpless

Winter varieties

Sharpless, Puebla, and Fuerte

Several of these varieties may be superseded within a short time by others which are now being tested in California. It is not to be expected that the industry can settle down to the cultivation of a few standard sorts until all of the promising ones have been tested, and this may require several years.

In Florida, the only variety which was extensively planted during the first fifteen years of the industry was Trapp. With the introduction of the Guatemalans, however, the question has become more complicated, and it will take some time to determine by actual trial which members of this race are most suitable for cultivation in different parts of the state.

It is probable that varieties will be obtained which will make it possible, both in California and Florida, to market avocados in every month of the year. Indeed, it is

almost possible to do so at the present time. In other regions horticulturists should work toward this end by obtaining for trial varieties ripening at different seasons.

West Indian race.

This race is the predominant one in the West Indies and throughout the low-lying portions of the tropical American mainland. It is found as far north as Florida and the Bahama Islands, and as far south as central Brazil. From its home in America it has been carried to Madeira, the Canary Islands, and parts of tropical Africa, Oceania, and the Indo-Malayan Archipelago. It is much more widely disseminated than either of the other races. The name South American race is sometimes applied to it, while P. H. Rolfs⁵ termed it the West Indian-South American.

Practically all of the avocados cultivated in Florida previous to the introduction of the Guatemalan were of this race. In California it has never been extensively grown; only a few trees, in fact, are known to have fruited in that state. It is the most susceptible to frost of the three races, and is best suited to cultivation at low elevations in the tropics.

The foliage of the West Indian race lacks the anise-like scent which characterizes the Mexican; in general, it resembles the foliage of the Guatemalan closely, but often the young branchlets and the leaves are lighter in color. The fruits are produced on short stems; the smallest weigh 4 or 5 ounces, the largest 3 pounds or more. The surface is nearly always smooth, yellow-green to maroon in color, the skin rarely more than 1/16 inch thick, pliable and leathery in texture. The seed is usually large in proportion to the size of the fruit and often loose in the seed cavity. The cotyledons are often rough on the surface, with the two seed-coats frequently thick and separated, at least over the pointed end of the seed, one of the coats sometimes adhering to the cotyledons and the other to the wall of the seed cavity. The flowers are characterized by less pubescence than those of the Mexican race, but are very similar to those of the Guatemalan; sometimes they are almost devoid of pubescence. The flowering season is from February to March in Florida, the fruit maturing from July to November, in certain varieties sometimes remaining on the tree until December or January.

Pollock (Fig. 4). — Form obovate to oblong-pyriform; size very large to extremely large, weight commonly 25 to 35 ounces, but occasionally attaining to 50 ounces, length 6½ to 7½ inches, greatest breadth 4 to 5 inches; base narrow, flattened slightly, with the short stem inserted obliquely in a shallow, flaring, regular cavity; apex obliquely flattened or slightly depressed; surface smooth, light yellowish green in color, with numerous small greenish yellow or russet dots; skin less than 1/16 inch thick, separating very readily from the flesh, tough and leathery; flesh firm, smooth and fine in texture, deep yellow changing to yellowish green close to the skin, almost without a trace of fiber discoloration; flavor rich, rather dry, very pleasant; quality excellent; seed conic, oblique at base, rather small, weighing about 4 ounces, usually fitting snugly in the cavity but sometimes loose, the seed-coats rather loose, more or less separate; season August and September at Miami, Florida. Originated at Miami, Florida; first propagated in 1901. It has been planted more extensively than any other West Indian variety except Trapp. It is

⁵ Bull. 61, U.S. Dept. Agr.

remarkable for its large size and excellent quality.

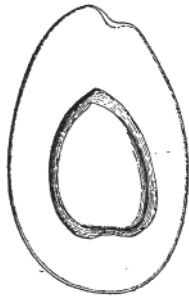


FIG. 4. The Pollock avocado. ($\times \frac{3}{4}$)

Trapp (Fig. 5). — Form roundish oblate, obliquely flattened at the apex; size large to very large, weight 16 to 24 ounces, length 4 to 4½ inches, greatest breadth 4¼ to 4¾ inches; base narrowing slightly, flattened around the deep, narrow, rounded, regular cavity in which the short stem is inserted; apex obliquely flattened; surface smooth to undulating or slightly pitted, pale yellow-green in color, with numerous small to medium sized, irregular, pale greenish yellow dots; skin 1/16 inch

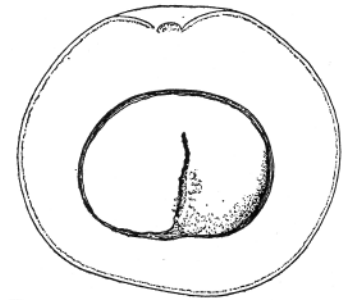


FIG. 5. The Trapp avocado. ($\times \frac{3}{8}$)

thick, separating very readily from the flesh, firm, leathery and pliable; flesh firm, very smooth, rich cream-yellow, changing to pale green, near the skin, fiber discoloration very slight; flavor moderately rich, pleasant, quality good; seed broadly oblate, large, about 5 ounces in weight, nearly tight in the cavity, with the seed-coats adhering more or less closely to the cotyledons or sometimes to the lining of the cavity. Season commencing in late September or October at Miami, Florida, and extending until the end of December, with a few fruits hanging on until the end of February or March.

Originated at Coconut Grove, Florida; first propagated in 1901. An unusually late variety, and for this reason valuable. It was the only avocado planted extensively in Florida previous to the introduction of the Guatemalans. The tree is very productive, but is a weak grower and susceptible to frost.

Waldin. — Form oblong to oblong-pyriform; size large to very large, weight 18 to 28 ounces, length 5 to 6½ inches, greatest breadth ¾ to 4½ inches; base somewhat narrowed with the rather short thick stem inserted squarely; apex slightly flattened; surface smooth, usually without markings; skin 1/16 inch thick, separating readily from the flesh, tough and leathery in texture; flesh firm, deep yellow in color, smooth, with very little trace of fiber; flavor rich and pleasant; quality excellent; seed obovate, rather large, weighing about 5 ounces, usually tight in the cavity. Season October until early January at Homestead, Florida.

Originated near Homestead, Florida; first propagated in 1915. The tree is a strong grower, productive, and more resistant to cold and to fungous diseases than the average variety of its race. Valuable on account of its lateness in ripening, and the good quality of its fruits.

Guatemalan race.

Although planted in California as early as 1885, the Guatemalan race did not begin to attract attention until about 1910. With the increase of interest in avocado culture which had its inception in California about that time, a number of fruiting trees were brought to light; most of them grown from seed introduced about 1900 by John Murrieta of Los Angeles, although the first tree was planted by Jacob Miller at Hollywood. Because of the excellent commercial qualities of the fruits produced by these seedlings and the season at which they ripened, several of them were propagated and named as horticultural varieties. The number has now increased, both through the fruiting of seedlings locally and the introduction of selected varieties from southern Mexico and Guatemala, especially from the vicinity of Atlixco, Puebla, Mexico, which was the source of most of the seeds introduced by Murrieta and has since furnished budwood of many choice varieties.

In Florida this race came into notice even later than in California. Several trees grown from seeds sent from Guatemala by G. N. Collins about 1901 came into bearing at the Miami Plant Introduction Garden in 1911-1912, and their season of ripening; February to April, immediately stimulated interest in this race, since a winter-ripening avocado had been the greatest desideratum of Florida growers. Budwood of practically all the varieties growing in California was obtained, and the first offspring of these came into bearing at Miami in 1915. While it can thus be seen that the Guatemalan race is new to Florida, it promises to become of great commercial value, and it has the decided advantage that its culture will be possible farther north than that of the West Indian race. Up to the present the trees are successful under Florida conditions. The varieties that have so far fruited ripen from October to May.

In other countries the distribution of this race is limited. It was introduced into Hawaii in 1885, and has recently begun to attract attention in that territory. Lately it has been planted in Cuba, where it promises to be successful. It has also been introduced into Puerto Rico and a few other regions, but only within the last few years.

The foliage of the Guatemalan race, as of the West Indian, lacks the anise-like odor which characterizes the Mexican. It is commonly deeper colored than the West Indian, the new growth often being deep bronze-red. The fruits, weighing 4 ounces to more than 3 pounds (commonly 12 to 20 ounces), and borne on long stems, are light green to purplish black in color. The surface is often rough or warty, especially toward the stem end of the fruit. The skin is usually over 1/16 inch, sometimes 1/4 inch, thick. This characteristic, together with the texture of the surface, is variable, occasional forms being found which have the skin scarcely thicker or rougher than in the West Indian race. It is usually harder, however, and more coarsely granular in character. The seed completely fills the cavity. The cotyledons are nearly or quite smooth, the seed coats thin, closely united, and adherent to the cotyledons throughout. The flowers, more finely pubescent than in the Mexican race, are similar in character to those of the West Indian. They appear much later than those of the Mexican race, usually beginning to open in late spring, about the time those of the West Indian race (in Florida) are setting fruits. Unlike both the other races, the fruit does not ripen in the ensuing summer, but is carried over into the following autumn, winter, or spring; while in California, fruits which develop from flowers appearing in June may remain on the tree until a year from the following October. The ripening season in general is winter and spring in Florida, somewhat later in California, where the earliest varieties at present cultivated begin to ripen late in January or in February, and the latest ones hang on the tree until October.

Blakeman. — Form broad pyriform to obconic, oblique, broad at the basal end; size above medium to very large, weight 14 to 20 ounces, length 4 to 4¾ inches, greatest breadth 3¼ to 3¾ inches; base rounded, the long stem inserted obliquely in a very shallow cavity; apex broadly rounded, obliquely flattened or slightly depressed on one side, with the stigmatic point raised; surface slightly undulating to roughened, but not so rough as in many other Guatemalan varieties, dark green with numerous large yellowish or reddish brown dots; skin thick and woody, separating readily from the flesh, brittle, granular; flesh fine-grained, firm, deep cream-yellow in color, tinged with green near the skin, free from fiber or discoloration;

flavor rich, pleasant; quality very good; seed broadly conic, medium sized, fitting tightly in the cavity with both seed-coats adhering closely. Season April to August at Hollywood, California.

Originated at Hollywood, California; first propagated in 1912, under the provisional names *Habersham* and *Dickey No. 2*.

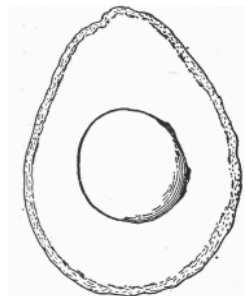


FIG. 6. The Dickinson avocado. ($\times \frac{3}{4}$)

Dickinson (Fig. 6). — Form oval to obovate, sometimes almost pyriform; size small to medium, weight 9 to 14 ounces, length $3\frac{1}{2}$ inches, greatest breadth $2\frac{3}{4}$ inches; base not noticeably flattened, the long stem inserted in a very small and shallow cavity; apex rounded; surface very rough, verrucose or tuberculate around the base, dark purple in color with large, irregular, maroon dots; skin very thick, especially near the base, separating fairly readily from the flesh, coarsely granular, woody, brittle; flesh buttery, pale greenish yellow, free from fiber, of pleasant flavor; quality good; seed roundish oblate, medium sized, tight in the cavity, with both seed-coats adhering closely. Season June to October at Los Angeles, California.

Originated at Los Angeles, California; first propagated in 1912. Vigorous in growth and precocious in fruiting.

Lyon. — Form broad pyriform, indistinctly necked, and sometimes oblique at the apex size above medium to large, weight 14 to 18 ounces, length about $5\frac{1}{2}$ inches, greatest breadth $3\frac{1}{2}$ inches; base narrow, the long stout stem inserted obliquely almost without depression; surface undulating to rough, bright green in color, with numerous small yellowish or russet dots; skin moderately thick, separating very readily from the flesh, coarsely granular, brittle; flesh smooth, firm, deep cream colored, tinged with green toward the skin, free from fiber discoloration, the flavor very rich and pleasant; quality very good; seed broad conic, medium small to medium in size, fitting tightly in the cavity with both seed-coats adhering closely. Season April to August at Hollywood, California. Originated at Hollywood, California; first propagated in 1911. The tree is precocious in bearing, and the fruit is of excellent quality.

Sharpless. — Form slender pyriform to elongated pyriform with a long neck; size large to very large, weight 16 to 24 ounces, length 6 to $6\frac{1}{2}$ inches, greatest breadth $3\frac{1}{4}$ inches; base very narrow, the long stem inserted obliquely without depression; apex rounded; surface slightly roughened or pitted, glossy, greenish purple to deep purple in color, with numerous yellowish dots; skin thick, separating readily from the flesh, granular and woody; flesh smooth, firm, cream colored, free from fiber discoloration, and of unusually rich pleasant flavor; quality excellent; seed oblate-oblique, small, weighing $1\frac{1}{4}$ ounces, fitting tightly in the cavity, with both seed-coats adhering closely. Season October to February at Santa Ana, California.

Originated near Santa Ana, California; first propagated in 1913. This is a fruit of fine quality, ripening very late in season.

Solano. — Form broadly obovate to oval; size above medium to large, weight 16 to 24 ounces, sometimes attaining to 28 ounces, length $5\frac{3}{4}$ inches, greatest breadth $3\frac{7}{8}$ inches; base rounded, with the long stem inserted obliquely without depression; apex oblique, slightly flattened; surface nearly smooth, somewhat glossy, bright green in color with numerous greenish yellow dots; skin moderately thick, separating readily from the flesh, granular; flesh firm, smooth, yellowish cream color, greenish near the skin, free from fiber discolorations and of mild pleasant flavor; quality fair; seed broadly conical to broadly ovate, small, fitting tightly in the cavity, with both seed-coats adhering closely. Season March to May at Los Angeles,

California; October to November 15 at Miami, Florida.

Originated at Hollywood, California; first propagated in 1912. Productive and a strong grower.

Spinks. — Form broadly obovate, or obconic; size extremely large, weighing from 18 to 34 ounces, length about 5 inches, greatest breadth about 4½ inches; base narrow, rounded, with the rather short stout stem inserted almost squarely without depression; apex rounded; surface roughened, warty around the base, dark purple in color; skin thick, separating readily from the flesh, woody, granular, brittle; flesh firm, smooth, rich yellow in color, free from fiber, and of rich pleasant flavor; quality very good; seed nearly spherical, small, weighing 3 ounces, fitting tightly in the cavity with the seed coats adhering closely. Season April to August at Duarte, California.

Originated at Duarte, California; first propagated in 1915. The tree is vigorous and productive, and the fruit of excellent quality.

Taft (Fig. 7). — Form broad pyriform, slightly necked; size above medium to very large, weight 14 to 24 ounces, length 5 to 5½ inches, greatest breadth 3¾ inches; base tapering, the long stem inserted obliquely without depression; apex rounded, with the stigmatic point raised; surface undulating to roughened around the base, deep green in color, with numerous yellowish dots; skin thick, separating very readily from the flesh, granular, rather pliable; flesh firm, smooth, light yellow in color with no trace of fiber discoloration; flavor unusually rich and pleasant; quality excellent; seed broadly conical, medium sized, fitting tightly in the cavity with both seed-coats adhering closely. Season May to October in southern California.



FIG. 7. The Taft avocado. ($\times \frac{3}{4}$)

Originated at Orange, California; first propagated in 1912. The tree is a strong grower but has not proved very frost-resistant in Florida. Its bearing habits have not been satisfactory in California, but in Florida they promise to be better.

Taylor. — Form pyriform to obovate; size medium to large, weight 12 to 18 ounces, length 4 to 4½ inches, greatest breadth 3¾ inches; base tapering, usually not distinctly necked, the long stem inserted obliquely almost without depression; apex rounded; surface undulating to rough, dull green in color, with numerous small yellowish dots; skin 1/16 inch thick, separating readily from the flesh, granular and woody; flesh firm, smooth, yellowish cream color, pale green near the skin, free from fiber, and of fairly rich pleasant flavor;

quality very good; seed conical, medium sized, tight in the cavity with both seed coats adhering closely. Season January 15 to April 1, at Miami, Florida.

Originated at Miami, Florida; first propagated in 1914. This variety has been planted only in Florida, where it has proved to be vigorous and reasonably productive.

Mexican race.

This race, which embraces the hardiest avocados cultivated in the United States, is particularly valuable for regions too cold for the West Indian and Guatemalan varieties. It is extensively cultivated in the highlands of central and northern Mexico, whence seeds have been brought to California, resulting in numerous seedling trees scattered throughout the southern half of the state. In Florida it has never become popular, but good varieties have not been introduced until recently. Some of them promise to prove of value for the colder sections of that state.

From its native home in Mexico this race has spread to several other regions, most

notably Chile, where it appears to be well known. It is the only race grown successfully in the Mediterranean region, trees having fruited at Algiers, in southern Spain, along the Riviera in southern France, and even in such a cold location as that of Rome. In tropical regions outside of Mexico it seems to be little cultivated.

The anise-like scent of the foliage and immature fruits is the most distinctive characteristic of the race and the one by which it is usually identified. The leaves are commonly smaller than those of the Guatemalan and West Indian races, and sharper at the apex. The fruit is small, 3 to 12 ounces in weight, rarely 15 or 16 ounces. The skin is thin, often no thicker than that of an apple, and usually smooth and glossy on the surface. The color varies from green to deep purple. The seed is commonly larger in proportion to the size of the fruit than in the Guatemalan race. The seed-coats are both thin, sometimes closely united and adhering to the cotyledons, sometimes separating as in the West Indian race. The flowers are heavily pubescent, and appear in winter or early spring, sometimes as early as November and usually not later than March. The fruit ripens in summer and autumn, commencing in June in Florida and August in California. Sometimes a second crop is produced from late flowers, ripening from March to May in California.

Northrop (Fig. 8). — Form obovate to pyriform, sometimes distinctly necked; size small, weight 5 to 8 ounces, length 4 inches, greatest breadth $2\frac{1}{2}$ inches; base narrow, the slender stem inserted squarely almost without depression; apex rounded; surface smooth, very glossy, deep purple in color, with a few small maroon dots; skin thin, adhering closely to the flesh, membranous; flesh buttery, cream yellow in color, practically free from fiber, and of rich flavor; quality good; seed oblong-conic, small, fitting tightly in the cavity with the seed-coats both adhering closely. Season October and November at Santa Ana, California, with a second crop maturing in April and May.

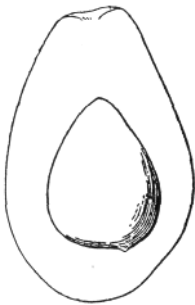


FIG. 8. The Northrop avocado. ($\times \frac{3}{8}$)

Originated near Santa Ana, California; first propagated in 1911 under the name Sells. The tree is vigorous, frost-resistant, and productive.

Puebla (Fig. 9).—Form obovoid, slightly oblique; size below medium to medium, weight 8 to 10 ounces, length $3\frac{1}{2}$ inches, greatest breadth 2 inches; base obliquely flattened, the stem inserted slightly to one side in a small shallow cavity; apex obliquely flattened but not prominently so; surface smooth, glossy, deep maroon-purple in color, with numerous reddish dots; skin less than $\frac{1}{32}$ inch thick, easily peeled from the flesh, firm in texture;

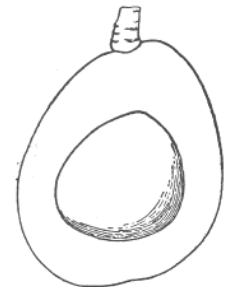


FIG. 9. The Puebla avocado. ($\times \frac{3}{8}$)

flesh rich cream yellow near the seed, changing to pale green near the skin, buttery in texture, and of rich nutty flavor; quality very good; seed medium to large, tight in the cavity, with both seed-coats adhering closely to the cotyledons. Season December to February in southern California.

Originated at Atlixco, state of Puebla, Mexico; first propagated in 1911, in which year it was introduced into California. A vigorous and hardy variety, fruiting later in the season than most others of its race.

Hybrids.

This group has been established to include hybrids between *Persea drymifolia* (the Mexican race of horticulture) and *P. americana* (the Guatemalan and West Indian races). Fuerte is the only variety which at present falls within it, and even this is not definitely known to be a hybrid. It bears, however, many evidences of hybridity, and cannot rightly be classified either with the Mexican or the Guatemalan races.

Fuerte. — Form pyriform (not necked) to oblong; size below medium to above medium, weight 10 to 16 ounces, length 4 to 4½ inches, greatest breadth 2½ to 2⅞ inches; base pointed; the stem inserted obliquely in a small shallow cavity; apex obliquely flattened, depressed around the stigmatic point; surface pebbled, sometimes slightly wrinkled around the stem, dull green, with numerous small yellow dots; skin about 1/24 inch thick, separating readily from the flesh, pliable and leathery in texture; flesh rich cream yellow in color, greenish near the skin, of smooth buttery texture, and very rich flavor; quality excellent; seed small, tight in cavity, seed-coats closely surrounding cotyledons. Season January to August in southern California.

Originated at Atlixco, state of Puebla, Mexico; first propagated in 1911, in which year it was introduced into California. An unusual variety, apparently a hybrid between the Guatemalan race of *Persea Americana* and the Mexican race (*P. drymifolia*). It is characterized by great vigor of growth, hardiness, good productiveness, and a long season of ripening differing from that of nearly all Guatemalan and Mexican varieties. The fruit contains as much as 30 per cent of fat, and is of very pleasant flavor.