Culture of the Oriental Persimmon in California

KNOWLES RYERSON

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IN CALIFORNIA

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INTRODUCTION

Though grown in California for half a century or more, the Oriental or Japanese persimmon is still a fruit of minor importance in the horticulture of the state. Interest in its culture has increased greatly in recent years, however, and much new acreage has been planted. The present total bearing and non-bearing plantings probably do not exceed one thousand acres, but this represents more than double the acreage of five years ago and new plantings are constantly being made. The fruit reaches the market in the fall and winter months during the holiday season and has met with considerable favor, for many years having returned a good profit to the growers. Until recently the persimmon has been grown primarily as a side line, but from present indications in the near future its culture will be an important industry in certain parts of California.

HISTORY AND SPREAD

The Oriental persimmon has been grown extensively in China and Japan for centuries, and the ancient literature of these countries contains many references to it. Marco Polo mentions the fruit in his account of his travels. Meyer reports that he found top-worked trees in China which were several centuries old and mentions whole valleys given over entirely to persimmon culture. In Japan, while there are districts where the fruit is especially cultivated, the trees are to be found, individually or in groups, widely scattered over the entire country.

The persimmon has long been the most widely used staple fruit of the Orient. Both fresh and dried, it fills an important place in the diet of China and Japan and has been referred to as "the apple of the Orient" as indicative of its importance there.

1 Formerly Specialist in Agricultural Extension and Farm Advisor in Los Angeles County.
The general name applied to the fruit in this state—the Japanese persimmon—would seem to indicate Japanese origin. The evidence, however, leads us to believe that it originated in China, from which country it was early taken to Japan. During the centuries in which it has been under cultivation in the Orient, many varieties have appeared and cultural practices have been developed to a high degree. In addition to the uses of the fruit, products from the tree, including the wood and stain, have found wide application in the industries and the arts of the Far East, to the extent that the persimmon tree is considered one of the important economic assets of that region. The Oriental persimmon was known in Europe and had been grown along the Mediterranean, especially on the Riviera, a hundred years before it was grown in the United States. Its cultivation there, however, has never been on a commercial scale.

The Oriental persimmon was introduced into the United States as a direct result of the memorable visit to Japan made by Commodore Perry in 1856. He secured some of the seeds and sent them to Washington where they were planted at the Naval Observatory. Four years later the first of the trees bore fruit. No distribution of seedlings from these trees was ever made and after some years they died. In 1863, William Saunders of the United States Department of Agriculture imported another supply of seeds, and trees were grown and distributed for trial. The first importation of grafted trees was made by the Department in 1870. This was a fairly large shipment but because of the long journey and the difficulty of keeping the long tap roots moist, most of the trees died. Among those that lived, however, were found several of the now best-known varieties including the Hachiya, Tanenashi and Yemon. Distributions from this importation were made throughout the southern states and in California. This shipment marked the beginning of extensive importations by both the Department of Agriculture and private concerns, which continued actively for more than two decades, during which time the trees became distributed throughout the states of the cotton belt and in all parts of California. Importations were continued on a much less extensive scale until June 1, 1919, when they were discontinued as a result of Quarantine Order 37 of the Federal Horticultural Board.

With the coming into production of the first trees in the southern states, a decided stimulus was given to commercial plantings. Varieties were tested, cultural problems studied, and the infant industry enjoyed the attention of a large number of investigators, which is reflected in the reports and bulletins issued by the United States Department of Agriculture, the state experiment stations, and horti-
cultural societies. Of those who have contributed most to the development of the industry in the South, no one person has done more than H. H. Hume of Glen Saint Mary, Florida, formerly of the Florida Agricultural Experiment Station, whose studies over a long period of years concerning the behavior of varieties, cultural practices, and especially pollination, have done much to remove uncertainties in the raising of persimmons in that region. Following the extensive plantings during the period just mentioned, interest waned. It was found that large quantities of persimmons could not be disposed of profitably as the public was unacquainted with the fruit and its uses. Planting ceased, except in a minor way and has not been resumed until within recent years.

The number of trees growing in the different southern states and California, together with their production (according to the last census, 1919) is shown in table 1.

<table>
<thead>
<tr>
<th>State</th>
<th>Trees of bearing age</th>
<th>Trees of non-bearing age</th>
<th>Total</th>
<th>Production Bushels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virginia</td>
<td>230</td>
<td>50</td>
<td>280</td>
<td>72</td>
</tr>
<tr>
<td>Georgia</td>
<td>225</td>
<td>45</td>
<td>270</td>
<td>55</td>
</tr>
<tr>
<td>Florida</td>
<td>5,180</td>
<td>12,469</td>
<td>17,649</td>
<td>5,473</td>
</tr>
<tr>
<td>Alabama</td>
<td>5,912</td>
<td>1,895</td>
<td>7,807</td>
<td>1,182</td>
</tr>
<tr>
<td>Mississippi</td>
<td>427</td>
<td>494</td>
<td>921</td>
<td>224</td>
</tr>
<tr>
<td>Louisiana</td>
<td>91</td>
<td>129</td>
<td>220</td>
<td>149</td>
</tr>
<tr>
<td>Texas</td>
<td>2,090</td>
<td>1,882</td>
<td>3,922</td>
<td>822</td>
</tr>
<tr>
<td>California</td>
<td>13,847</td>
<td>7,500</td>
<td>21,347</td>
<td>21,452</td>
</tr>
</tbody>
</table>

Within the past few years, however, interest has again been manifested in the commercial production of the Oriental persimmon in the southern states, and new plantings have been made. The new non-astringent variety known as Fuyu and the one supposed by some to be identical with it, Fuyugaki, have been planted in considerable numbers; these are described on page 28. The area in the southern states which can be devoted to persimmon growing is large, and as the public becomes increasingly familiar with the uses of the fruit, it is reasonable to expect that there may again be a marked increase in acreage in that region.

As has been mentioned, California received some of the first importation of grafted trees made in 1870 and others in the years immediately following. These were planted in all parts of the state.
Rev. Henry Loomis at this time began large importations direct to San Francisco, and for several years afterwards distributed hundreds of trees. Some of the first to come into bearing were located on the place of Colonel Hollister at Santa Barbara. The fruits from these trees weighed from one-half to a pound or more and excited much curiosity and attention. At about this time some of the plantings were made which have since become famous throughout the state. The Elwood Cooper orchard in Santa Barbara on the now famous Elwood ranch was set out during this period. Car-lot shipments were sent from this orchard for years.

In 1874, R. H. Gilman planted an acre of supposedly Hachiya trees on what is now the McCulloch Ranch between Fullerton and Placentia. The planting proved to contain over forty varieties. Because of unsatisfactory market conditions most of the trees were later removed. However, one of them still remains and has an interesting history. Scions were taken from this tree by C. P. Taft and inserted in trees on his place near Orange. When they came into bearing, the fruit was markedly superior to the ordinary strain of the Hachiya. He took scions from these trees and inserted them in trees on the present Thales ranch, within a short distance from the original parent tree. It is from this start that the splendid orchard on that ranch has been developed.

In 1876 the first planting was made in Placer County on the Ira Avery place. One of the trees of the original planting, of the Tsuru variety, is still alive. This first planting consisted of but a few trees, but because of their success, the planting was gradually extended until it now comprises about 40 acres. Other plantings were made in the county in the years following, but development was slow.

As the interest in the fruit increased, the California Experiment Station undertook the testing of some of the varieties both at Berkeley and at the sub-stations, notably at Jackson in Amador County. The report of 1880 recorded the fact that fruits ripened at Berkeley but they were small and astringent. With the exception of occasional reduction of crop from spring frost damage the planting at Jackson was highly successful, corroborating the experience in Placer County that the tree is admirably suited to the foothill region of the Sierra Nevada range.

The period since the earlier introductions has been marked by a very slow expansion in persimmon plantings until quite recently. Persimmon growing has been maintained as a sideline rather than a major crop. The fairly high return that has been received over a long period of years, maintained primarily because of the relatively slow
increase in production, at last attracted attention, with the result that the past five years have witnessed a rapid expansion in planting, particularly in southern California, but also in other parts of the state. The total acreage has about doubled in this time. Realizing that such an unusual increase in production would be certain to result in greatly reduced prices unless consumption could be increased, the persimmon growers of southern California recently took steps to effect an organization to further their interests and to unite their efforts in the solution of their problems. Preliminary steps were taken in the fall of 1922, and in the following spring an organization known as the Persimmon Growers Department of the Southern Counties Farm Bureaus was launched. Its program included a survey of the industry in both California and the southern states, a study of the root-stocks now in use, the appointment of a committee for the study and the elimination of all but a very few of the best varieties for commercial planting, and a study of marketing practices with a view to standardization of methods of packing, handling, and selling. A part of the first report of the variety committee is given in a later section. Standards have been set for packing and grading, and in 1924 the first steps were taken toward controlling the sale of the fruit. The survey undertaken furnished the basis for a careful analysis of the industry, thus laying the foundation for sound development in the future. In 1924 a similar organization movement was started in the northern persimmon-growing districts in the formation of the Northern California Persimmon Association.

The part played by the United States Department of Agriculture in the development of the persimmon industry has been a most important one. Through the continuous search by explorers and others in the Orient, the best varieties have been brought in for trial and propagation. One of those recently introduced promises to have a very marked effect on the future of the industry. This variety, the Fuyu, a clear-fleshed, non-astringent fruit, has been so eagerly sought by those setting out orchards during the past two years that there has not been nearly enough stock to supply the demand either in California or in the southern states. The name of the veteran plant explorer, the late Frank N. Meyer, is closely associated with this and other varieties which he introduced as a result of his travels. At the Government Plant Introduction Garden at Chico, California, there is maintained a trial orchard containing the introductions of the United States Department of Agriculture, which serves to supply much-needed information on the possible commercial value of these introductions.
The Oriental persimmon belongs to the family botanically known as the Ebenaceae or Ebony family. Members of this family comprise a large group of deciduous and evergreen trees and shrubs finding wide use as ornamental, fruit-bearing and timber-producing trees. The genus Diospyros—named from Dios, meaning Jove, and pyros, grain, literally “food of the gods” because of the excellence of the fruits—contains nearly two hundred species, about a hundred and ninety of which are found in the tropics and the remaining few in the temperate zone. Many of them are of economic importance, notably those producing the ebony wood of commerce.

The trees are either dioecious or monoecious, the staminate flowers appearing in the axils of the leaves of the previous year; staminate flowers smaller than the pistillate, commonly in the three-flowered cymes; pistillate flowers generally solitary; calyx four-lobed, the lobes contorted in the bud, more or less contracted in the throat, the lobes spreading or recurved; stamens sixteen to twenty-four in number inserted on the bottom of the corolla in two rows and in pairs; filaments free, slender; anthers oblong, the cells opening laterally by longitudinal slits; stamens mostly rudimentary or wanting in the pistillate flowers although perfect flowers are sometimes found; ovary usually four-celled, each cell more or less completely divided; styles four, spreading, two-lobed at the apex; stigmas two-parted or lobed; ovule solitary in each of the divisions of the cells. Fruit globose, oblong, or conical, one to ten-seeded, surrounded at the base by the enlarged persistent calyx. Seeds pendulous, oblong, compressed; seed coat thick and bony, dark, more or less lustrous.

Several members of the genus are native to the American continent and bear fruits that are used to some extent. The most widely known is the native American persimmon (D. virginiana) which grows from Connecticut to Florida, and as far west as eastern Kansas and Oklahoma. Several improved and named varieties have been developed. Its use as a rootstock for the Oriental persimmon will be discussed later. Diospyros texana, a native of the Colorado and Concho river regions in Texas, yields a fruit that is extremely astringent until fully ripe, and finds little use except as a source of dye for staining black, for which purpose the Mexicans employ it to a limited extent. D. ebenaster, the sapote negro of Mexico, bears a fruit green in color and resembling a large, oblate apple. The soft flesh is almost black and not attractive in appearance. It is very sweet and cloying, resembling many other fruits of the tropics. It is too tender to grow in southern California.

Another member of the genus of importance but native to China rather than this country, is Diospyros lotus. This species has been known to botanists for a long time, but was not used as a rootstock
Fig. 1.—Flower forms of the Oriental persimmon. A, Staminate flowers. B, Pistillate flowers.
until Meyer called attention to its value for this purpose. It is found growing wild in the mountainous parts of northern China and bears quantities of small fruits that turn black when ripe. They are about the size of cherries and are used in large quantities by the natives. The tree is usually dioecious. This species has found wide use in California as a rootstock upon which the kaki varieties are grafted. Its use in this connection will be discussed in detail in the section devoted to rootstocks. Many trees of this species are fruiting in California. As far back as 1882, the report of the California Experiment Station recorded the fact that it succeeded unusually well.

**Diospyros kaki.**—This species includes all of the true Oriental or kaki persimmons. It is native to China, from which country it has been taken to many other parts of the world. It has been under cultivation for centuries and is probably the most widely distributed and common fruit of both China and Japan.

The tree sometimes reaches a height of forty feet. The crown is commonly rounded, though in some varieties very few branches of any size develop, the fruit being borne on short pendant laterals, little or no crown being evident. The leaves vary considerably in shape, ranging from obovate and oblong-ovate to ovate or ovate elliptic, acuminate at the apex, glabrous above and more or less finely pubescent underneath. The color is a dark, glossy green, in some varieties changing to bright yellow and red in the fall. The flowers of this species caused much confusion both botanically and also from a practical point of view, until Hume made his thorough investigation of the flowering habits of the species, which cleared up the matter. Instead of being consistently dioecious as had been generally assumed, he found that three kinds of flowers may be produced—staminate, pistillate, and perfect. These three types may, though rarely, be found on a single tree. They are all borne on wood of the current season’s growth. The staminate blossoms are borne usually in three-flowered cymes in the leaf axils, or they may be found singly or in groups of two (fig. 1). The calyx and corolla are four-lobed. Two rows of stamens, sixteen to twenty-four in number, are inserted upon the corolla. The pistillate flowers are borne singly in the leaf axils; the leaf-like calyx is large; the four-parted corolla is yellowish-white when first open, turning brown later. The eight stamens are abortive; the ovary is flattened, globose, and contains eight cells; the short four-parted style is surmounted with a much branched stigma. Perfect flowers are usually found associated with the staminate flower clusters and are intermediate in character. They are a development from the staminate type, according to Hume.

In his investigation of the flowering habits of this species, Hume found that the different varieties vary markedly as to the types of blossoms borne and the regularity with which they are produced. Certain varieties consistently produce only pistillate blossoms; others

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produce both staminate and pistillate flowers in varying proportions from year to year, some years the number of staminate blossoms being exceedingly small or none. The number of perfect flowers produced is negligible and has no important effect on the fruitfulness of the tree. These studies have materially assisted in the solution of the problem of obtaining the setting of satisfactory crops in the southern states. The Tanenashi variety, he found, regularly set crops without pollination. Other varieties cannot be grown profitably in the southern states without provision for pollination. Hume classified the different varieties according to their flower bearing habits. Those which always bear staminate flowers are termed staminate constants; those which produce them irregularly are termed staminate sporadics; while those which bear only pistillate blossoms are termed pistillate constants. No varieties have been found which bear only staminate forms consistently.

<table>
<thead>
<tr>
<th>Pistillate Constants</th>
<th>Staminate Constants</th>
<th>Staminate Sporadics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hachiya</td>
<td>Gailey</td>
<td>Okame</td>
</tr>
<tr>
<td>Tanenashi</td>
<td>Masugata (probably)</td>
<td>Taber No. 23</td>
</tr>
<tr>
<td>Hyakume</td>
<td>Siang (S. P. I. 21910)</td>
<td>Taber No. 129</td>
</tr>
<tr>
<td>Tamopan</td>
<td>Miyotan (S. P. I. 47323)</td>
<td></td>
</tr>
<tr>
<td>Tsuru</td>
<td>S. P. I. 27037</td>
<td></td>
</tr>
<tr>
<td>Costata</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yemon</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yedo Ichi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zengi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phelps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triumph</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As a result of these discoveries concerning persimmon flowers, the difficulty of setting satisfactory crops in the southern states has been largely overcome by the use of the Gailey variety, which produces an abundant supply of staminate flowers annually. More recently a United States Department of Agriculture introduction, the Miyotan (S. P. I. 47323), has been found to be an excellent pollenizer.

While the problem of pollination is important in the southern states, experience in California has amply demonstrated that it is not of particular importance here. The Hachiya, the best commercial variety, sets fruit readily without pollination—hence they are usually seedless. In mixed plantings where pollination sometimes occurs seeded fruits are frequently produced. These are certainly not superior to the seedless fruits and in the opinion of many are distinctly inferior in quality. Black, discolored areas immediately surrounding some of the seeds are frequently found, which are apparently
caused by the influence of pollination and by many these are considered objectionable. The consensus of opinion of the California growers is that the Hachiya variety should be grown as a seedless fruit. Most, if not all, of the other varieties grown in California exhibit a tendency to overbearing rather than the reverse. The planting of staminate trees in California, therefore, does not appear to be justified, and pollination can probably be ignored as a problem that must be considered in planting commercial orchards.

The fruit of the Oriental persimmon shows wide variation in all its principal characteristics. In shape it varies from broad oblate to slender conical, including all shapes intermediate. In cross section gradations from circular to quadrangular are found. The surface, commonly smooth, is in some varieties marked by from four to eight shallow to deep grooves running lengthwise of the fruit. In some varieties, notably Tamopan, an equatorial construction circles the fruit in a characteristic manner. Other varieties are characterized by the presence of more or less prominent basal lobes under the sepals and this character is of assistance in the identification of some varieties. Saburoza is the only one of this group that is found commonly in California, although Tanenashi sometimes exhibits this characteristic to a slight degree. Some varieties possess the same type of structure present in the navel orange, a more or less clearly defined secondary fruit within the primary. This is particularly recognized in the variety Futaya, this word in Japanese meaning "double."

The apex of the fruit may be pointed, rounded, flat or depressed, the pointed apex being a distinct disadvantage in packing because of the greater possibility of injury. The base may be depressed, flattened, or projected beneath the calyx lobes.

The fruit varies notably in size, Zengi frequently having a diameter of not to exceed 1½ inches. Hachiya fruits are usually from three to four inches in length and from two to three inches in diameter and frequently weight a pound or more. Tamopan fruits sometimes have a diameter of from four to six inches.

The skin of the fruit varies much in thickness. In Hachiya it is thin and almost transparent, and tender when the fruit is mature, which makes handling difficult when the fruit is soft. The skin of Tamopan is thick and tough, permitting rather rough handling even when the flesh has become exceedingly soft. The color of the fruit varies from a yellowish-orange to a deep, tomato red. Many varieties are marked by finely penciled, dark lines circling the apex and extending irregularly down the sides.
The flesh is soft when ripe, in some varieties almost liquid, though dry and mealy in Tanenashi. It is yellow-orange in color in some varieties and red-orange in others. The flesh of many varieties is colored by a varying number of small, brownish specks, caused by the presence of tannin bodies. The number is sufficiently great in some fruits to give the flesh a decided chocolate color. The relation of pollination to these color characteristics will be discussed in another section.

While as many as eight elliptic, thin, dark brown seeds may be found, usually the number that develops is fewer and seedless fruits are common, particularly in Tanenashi and Hachiya.

TABLE 2
ANALYSES OF PERSIMMONS

<table>
<thead>
<tr>
<th></th>
<th>Percentage composition</th>
<th>Carbohydrates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Refuse</td>
<td>Water</td>
</tr>
<tr>
<td>Large seedling, edible portion</td>
<td>77.04</td>
<td>1.61</td>
</tr>
<tr>
<td>Large seedling, as purchased</td>
<td>22.40</td>
<td>59.77</td>
</tr>
<tr>
<td>Tanenashi, edible portion</td>
<td>81.93</td>
<td>1.16</td>
</tr>
<tr>
<td>Tanenashi, as purchased</td>
<td>1.88</td>
<td>66.53</td>
</tr>
<tr>
<td>Yemon, edible portion</td>
<td>81.66</td>
<td>1.32</td>
</tr>
<tr>
<td>Yemon, as purchased</td>
<td>30.7</td>
<td>56.59</td>
</tr>
<tr>
<td>Average, edible portion</td>
<td>80.21</td>
<td>1.36</td>
</tr>
<tr>
<td>Average, as purchased</td>
<td>23.97</td>
<td>60.96</td>
</tr>
</tbody>
</table>

Analyses of Persimmons.—The composition of the persimmon fruit has been studied by several investigators. The analyses given in table 2 were made and published in 1903 by the California Experiment Station. Earlier, in 1899, McBryde* made a study of the persimmon and its chemical composition and was unable to detect any trace of cane sugar in the large amount of total sugar present, all of it being in the form of glucose. The total amount of sugar present exceeds that of a number of the common fresh fruits, including the apricot, plum and peach.

ASTRINGENCY

The quality called "pucker" has long been associated with the persimmon fruit, indeed it has been largely influential in limiting the popular favor to which the fruit is entitled. This astringency is caused by the presence of tannin. Much study has been given to the behavior of the tannin in the ripening process, during which its undesirable effects disappear. At first it was supposed that the astringency was due to the presence of soluble tannin which became insoluble as the fruit ripened. Lloyd has shown that this theory is not in accord with the true behavior of the tannin masses within the fruit, but that apparently the tannin is associated with a carrier of a colloidal nature with which it completely unites during the ripening and softening process when its power to cause astringency is removed. This absorbed tannin undergoes oxidation in some varieties and appears as red-brown flecks scattered through the flesh, as is the case in the so-called "sweet" varieties. In these varieties the oxidation takes place before the fruit becomes soft, thus permitting them to be eaten while still firm. In some manner not yet fully explained, this oxidation is associated with the process of pollination and the physiological changes resulting therefrom. In certain varieties this oxidation always takes place after pollination, the flesh becoming chocolate-colored and the fruit puckerless; other varieties, notably Fuyu, Jiro, and several others, remain puckerless even though the flesh does not change color materially; while in still other varieties the development of seeds has no effect on the quality of astringency, the fruit remaining puckery until the ripening process is complete. Hume believes that this peculiar behavior may indicate a mixing of species in ancient times, with the present widely varying behavior of the different varieties as a result. The processing of the fruit to remove this astringency will be discussed in another section.

From the time of the first importation of nursery stock from Japan, there has been an almost hopeless confusion in the names of persimmon varieties. This has resulted partly from the carelessness of the exporters, orders having been filled, apparently, from any stock that happened to be on hand. On the other hand, a condition of great confusion and duplication in nomenclature exists in Japan, different communities and different sections of the country having different names for the same variety. This partially explains the more than eight hundred named varieties which, according to Ikeda,\(^1\) are to be found in that country.

Varieties that are clear-fleshed and seedless in one section have sometimes proved to be seeded and dark-fleshed in another. Several early attempts at an adequate classification are on record. The old Japanese system based upon sweetness or astringency is obviously unsatisfactory, because a variety may be in one group in one locality and in another in a different part of the country. One of the first horticultural schemes of classification was that proposed by Hume\(^6\) in 1904 in which all varieties were grouped into three classes—dark-fleshed, mixed light and dark, and light-fleshed—according to the color of the flesh. This classification is untenable, however, because as previously indicated, the changes in the color of the flesh of certain varieties are now known to be an effect of pollination.

Later studies have shown that all of the varieties grown in the United States are light-fleshed when seedless, but when seeds are present some are wholly or partially dark-fleshed, according to the number of seeds that develop. Based upon these studies, Hume\(^6\) later proposed a new classification which is still accepted as the most satisfactory yet presented. Those varieties which experience no change of flesh color when pollinated and seeds develop are designated as pollination constants; those which are light-fleshed when seedless but dark-fleshed when seeded are designated as pollination variants. No varieties have yet been found which are dark-fleshed both when seeded

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\(^{1}\) Ikeda, T. The fruit culture of Japan. (No date.)
Fig. 2.—Two types of Hachiya fruits commonly found in the markets. A, Broad type thought to be the Fuji. B, Standard or true Hachiya.
or seedless; hence no division of the *pollination constants* group has been necessary to separate the light and dark-fleshed varieties. While as a general rule all varieties of the Oriental persimmon are light-fleshed when seedless, exceptions to the rule have been noted. Condit reports the presence of cinnamon-colored flesh in seedless fruits which were believed to be of the Tsuronoko variety.

Under the classification just described, the better known varieties of the Oriental persimmon grown in California may be grouped as follows:

<table>
<thead>
<tr>
<th>Pollination Constants (light-fleshed when seeded or seedless)</th>
<th>Pollination Variants (light-fleshed when seedless, dark-fleshed when seeded)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hachiya</td>
<td>Hyakume</td>
</tr>
<tr>
<td>Tsuru</td>
<td>Gosho</td>
</tr>
<tr>
<td>Ormond</td>
<td>Yemon</td>
</tr>
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<td>Tanenashi</td>
<td>Yeddo Ichi</td>
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<tr>
<td>Costata</td>
<td>Maru</td>
</tr>
<tr>
<td>Fuyu</td>
<td>Okame</td>
</tr>
<tr>
<td>Tamopan</td>
<td>Zengi</td>
</tr>
</tbody>
</table>

**COMMERCIAL VARIETIES**

As a result of the early importations, California fruit growers planted a large number of different persimmon varieties, and although there has been a great reduction in the number of varieties planted in more recent years, there are still far too many for the best interests of the industry. The most important of these, both in point of acreage planted and popularity with both the buyers and the public, is the large-fruited, highly colored Hachiya (figs. 2 and 3). It is by far the most important variety in both northern and southern California, the newer plantings being composed almost exclusively of this variety.

Next in importance is Hyakume (fig. 3) ripening later than the Hachiya and less attractive because of its dull, mottled, yellow appearance. This variety is grown to a large extent in Placer County and to a lesser extent in southern California.

Grouped under the general name of Maru (fig. 3) a number of medium to small-fruited, round varieties are to be found in the older plantings—the name Maru being more properly a group or class name than that of any specific variety. A separation of the different varieties marketed under this name is hardly possible. Yemon, Okame, and Yeddo Ichi are all marketed in small amounts and to a still less degree Gosho, Tsuru, and the more recently introduced Tamopan (figs. 3 and 4).

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Tanenashi (fig. 5) formerly occupied a more important place than it does now in the state, though it offers more promise in the Imperial Valley than other varieties. The experience of growers in the southern states has been somewhat different from that of growers in California. There, Hachiya has not proved as satisfactory as Tanenashi, which is

\[ \text{Tamopan} \quad \text{Maru} \]

\[ \text{Hyakume} \quad \text{Hachiya} \]

**Fig. 3.**—Four of the principal varieties of persimmons grown in California, showing comparative size and shape of the fruits.

...the present ruling market favorite. Two varieties originating in the south have also been planted to a considerable extent—Lone Star, originating in Texas and Triumph, in Florida. Many other varieties are to be found in the persimmon districts of the South as in California and in the same way add to the problem of marketing.
Fig. 4.—Promising new persimmon varieties. A, Fuyu. B, Godbey Seedless. C, Tamopan.
Fig. 5.—The Tanenashi variety. Natural size.
In the past two or three years a new variety has been planted to a considerable extent both in California and the South—Fuyu (figs. 4 and 6), a yellow-fleshed, non-astringent persimmon that does not depend upon pollination to make it non-astringent when hard. Wherever the fruit has been tried it has excited interest and favorable comment and the demand for trees has far exceeded the supply. The variety was introduced by the United States Department of Agriculture from Japan. With the exception of Hachiya, in California, Fuyu is now the only variety, trees of which are in demand.

The shipment of mixed lots of misnamed or unnamed and undesirable persimmon varieties has been a serious handicap to the development of the industry in California. In view of the very evident preference of the dealers and the buying public for a few known varieties, the elimination of all others would undoubtedly prove to be of a great benefit to the industry. Such elimination would not be difficult if only the growers could be convinced of the benefits. The trees are easily topworked and the change could be made in the existing orchards without any great loss. The increase in returns from the premiums paid for the better varieties should more than make up for the loss of a few crops while the topworked trees are coming into bearing.

As a step in the direction of standardization of varieties, the Persimmon Growers Department of the Southern Counties Farm Bureaus in 1923 appointed a committee to study the varieties now being grown, as well as those now under trial by the United States Department of Agriculture. After careful investigation this committee recommended three varieties for commercial planting and two varieties for further trial. This report was adopted and is now being made the basis of a campaign for the top-working of off-types and of poor varieties to the standard recommended sorts. Part of the report of this committee is as follows:

The following three varieties are recommended for commercial planting in the order named, and a brief outline of their merits and drawbacks are presented herewith.

1. Hachiya.—Of all the persimmon varieties now grown or known in California this variety stands in a class by itself and is by far the most popular and is to be recommended above all others [figs. 2 and 3].

Merits.—Its large size, high color, and distinctive shape are already known and recognized by the trade and by the consuming public. The fruit ripens uniformly and is ordinarily seedless, with a clear yellow flesh whether needs are present or not. The flavor is exceedingly rich and pleasant.

Drawbacks.—The tree is a light bearer in some sections. When pollinated, black areas sometimes occur around the seeds which, while apparently normal,
Fig. 6.—The Fuyu variety.
The fruit remains on the tree a little later than the Hachiya and the variety is apparently a surer bearer except in the more favorable districts. The skin is tougher than that of the Hachiya. The flesh is firmer and the fruit dries in a more satisfactory manner. It is of large size and ships well.

Drawbacks.—The fruit is not so high in quality as the Hachiya. The color is not so deep nor so attractive. The flesh is somewhat dry and mealy and while preferred by some for eating with sugar and cream, it is ordinarily not so well liked as that of the Hachiya. The fruit is subject to a defect at the stem end; in many fruits an opening forms exposing the core to mold. The tree is not quite so vigorous or satisfactory a grower as the Hachiya [fig. 8].

3. Hyakume.—This variety is next to the Hachiya in popularity in Placer County but is not favored in southern California [fig. 3].
Merits.—The fruit has very good flavor and quality with a fairly thick skin. It is a good shipper and is later in season than the Hachiya, and consequently may be held later for marketing.

Drawbacks.—The color of the fruit is poor, frequently blotched with dark brown. Ripening is not very even, giving the fruit rather an unattractive appearance on the market. The flavor and quality is not so good as Hachiya.

The tree.—The tree is a poor grower, being upright in habit with weak laterals which tend to break and does not reach the size attained by Hachiya [fig. 9].

Fig. 8.—A tree of the Tamenashi variety.

Varieties Recommended for Further Trial

1. Tamopan [fig. 4].—

Merits.—The fruit is late in season and meets the requirements for the holiday trade. It is large and has a distinctive shape differing from most other varieties, being marked by a constriction from a quarter to halfway down on the fruit. This skin is unusually tough and will hold its shape, making a natural cup from
which the pulp can be spooned, even when the fruit is fully ripe and the flesh is almost of a watery consistency. The quality is very good, not quite as rich as the Hachiya but more pleasing to some.

Drawbacks.—The tree is a light bearer in some sections but has not been tested sufficiently for final opinion.

Fig. 9.—A tree of the Hyakume variety.

The tree.—An upright, vigorous grower, not so spreading as the Hachiya, but making a very satisfactory top, able to carry abundant crops [fig. 10].

2. Fuyu [figs. 4 and 6].—

Merits.—The fruit has a high color and a round flat shape which makes it pack well. Its non-astringent qualities commend it to many people and its rather pleasing flavor also recommends it. The tree is a good bearer and is a vigorous grower [fig. 11]. The variety has not been tested in southern California sufficiently to determine its adaptation and the fruit is not known to the trade nor to the consuming public. The fruit also contains a number of rather large seeds.
FRUIT DESCRIPTIONS

Abbreviated technical descriptions of the more important and better known varieties are here given. These have already appeared in complete form as indicated and may be referred to in the event that more detailed descriptions are desired.

Fig. 10.—A tree of the Tamopan variety.

Hachiya (figs. 2, 3, and 7).—Fruit very large, oblong-conical, usually deep orange-red, very attractive; surface glossy; flesh astringent until soft; sweet, rich, excellent in quality; usually seedless; the leading commercial variety, although regarded as a light bearer in some sections; often bearing heavily in alternate years. Season medium. Especially fine in Orange County. Colored plate and description in the U. S. Department of Agriculture Yearbook for 1887, p. 644. Probably identical with Fuji of Japan.
Hyakume (figs. 3 and 9).—Fruit medium to large, mostly four-angled; color light orange, often mottled or dappled and unattractive at maturity; brown when soft; surface glossy, usually with fine russet lines around the apex and down the sides; flesh dark cinnamon color when seeded; sweet, moderately rich; quality very good; keeping quality excellent. Season medium. Colored plate and description in the U. S. Department of Agriculture Yearbook for 1880, p. 450.

Tanenashi (figs. 5 and 8).—Fruit large, broadly conical, tapering gradually upward from near the base; color light orange-red; surface fairly glossy, smooth, with distinct areolations visible through the skin; flesh astringent until soft, characteristically mealy or pastry; of very good quality; practically always seedless; fruits often defective at the core, with an opening under the calyx exposing the interior to dust, dirt, and mold. Season medium. Trees bear heavily in alternate years. Colored plate and description in U. S. Department of Agriculture Yearbook for 1887, p. 644.
Fuyu (figs. 4, 6, and 11).—Fruit medium to large, indistinctly quadrangular; color deep tomato-red, attractive; surface fairly glossy; flesh light orange, fairly rich; perfectly non-astringent even when seedless and firm; quality very good; seeds few or none. Above description refers to fruit produced on tree at Plant Introduction Gardens, Chico, imported under S.P.I. No. 26491. A very promising variety. Fruits of S.P.I. No. 29888 are very similar if not identical. S.P. I. No. 26733 has fruited in Florida and is regarded as the most promising variety yet tested. Trees of the same number have fruited at Mountain View, California, the fruits being entirely non-astringent. It was introduced under the name Fuyugaki.

Tamopan (figs. 4 and 10).—Fruit very large, often from three to five inches in diameter and sometimes over a pound in weight; usually more or less quadrangular with a prominent equatorial constriction or crease below the middle; color light red-orange changing little at maturity; skin thick and tough, enabling one to eat the flesh with a spoon from the half shell; flesh light orange, very juicy, stringy, mostly astringent until soft, fairly rich; quality very good; usually seedless. Season medium. Tree hardy, vigorous, productive. First introduced by the United States Department of Agriculture from China in 1905.

Maru (fig. 3).—Fruit medium with a broad, rounded apex; color orange-red, attractive; surface somewhat glossy, with heavy bloom; flesh dark cinnamon when seeded, very sweet, rich; quality excellent. Tree a regular heavy producer in Placer County; season medium.

The name Maru, meaning round, is used as a suffix of several variety names such as Zengi-maru, Daidai-maru and Sagami-maru, signifying that the fruits have a general roundish form. The name should properly be used, therefore, as a type rather than a variety name. The same is true of the name “Kineri.”

Saburoha.—Fruit small to medium, characterized by four prominent lobes or “seats” extending beyond the calyx; color very dark tomato-red, very attractive; surface glossy; flesh very dark cinnamon when seeded, sweet, rich; quality excellent. Illustrated and described in the California Cultivator, January 28, 1915.

Tsuru.—Fruit oblong-cylindrical with rounded apex; longer in proportion to its size than any other variety; color bright orange-red, attractive; skin smooth, glossy, rather thick, granular; flesh astringent until soft, often failing to ripen uniformly; quality good; usually seedless. Season late. Fruit especially sought after by Orientals. Colored plate and description in the U. S. Department of Agriculture Yearbook for 1890, p. 423.

The Costata illustrated and described in the U. S. Department of Agriculture Yearbook for 1892, p. 265; the Ormond (Yearbook for 1913, p. 270, 271); and probably the Yama Tsuru (Yearbook for 1891, p. 387) belong to the same group as the Tsuru.

Yedo Ichi.—Fruit often more roundish than flattened, medium, apex slightly depressed at center; color very dark tomato-red, attractive; surface somewhat glossy, usually marked with fine penciled lines around the apex; flesh very dark cinnamon when seeded, sweet, rich; quality excellent. Colored plate and description in the U. S. Department of Agriculture Yearbook for 1889, p. 450.

Yemos.—Fruit medium, decidedly flattened and quadrangular color light orange-red; surface somewhat glossy with a heavy ashy-gray bloom; flesh cinnamon when seeded, sweet, fairly rich; quality good. Season late. Tree a very heavy, regular producer. Seedless specimens illustrated in color and described in the U. S. Department of Agriculture Yearbook for 1887, p. 644.
The Yama Yemon is very similar to the Yemon, but generally larger, earlier and often furrowed on the four sides.

Zengi.—Fruit small; color dark orange red, attractive; surface glossy, often marked with russet lines around the apex; flesh very dark, almost black when seeded, sweet, rich; quality very good. Season early. Fruit too small for commercial use. The Gailey, Taber's 129, and Miyotan, grown in the southern states belong to this group.

CLIMATIC REQUIREMENTS

TEMPERATURE

The Oriental persimmon is distinctly a subtropical fruit. While it is found in the northern part of the mainland of Japan, and withstands zero weather in China, it does not reach the perfection there that it does in the milder, southern parts of these countries. In the United States it has failed to grow satisfactorily as far north as Washington, D. C., and, as has been indicated, is suited only to the states of the cotton belt and to California. This is also the experience in Europe where its finds a congenial home only along the shores of the Mediterranean. In general the persimmon may be said to be limited to the same climatic zone as the fig; however, the same amount of high summer heat and lack of humidity are not required to mature the fruit, as is evident from the fact that in California excellent quality fruit is produced in the coastal belt of southern California where the humidity is commonly high and the daily temperature range much lower than in the interior regions. The season of ripening in the cooler districts of the state is somewhat later than in the interior valleys, but as the fruit is grown primarily for the holiday trade this is a distinct advantage.

With the exception of the foothill areas, the persimmon has not been tested as thoroughly in the hotter interior sections as it has in other parts of the state, and its behavior in these regions is not as well known. Trees are bearing in the Imperial Valley and in the south San Joaquin Valley. The poor showing made by some of these plantings may possibly be caused by lack of sufficient irrigation rather than by intense heat and dryness of the atmosphere. Observations made by Packard on the behavior of the persimmon in the Imperial Valley indicate that the trees are quite sensitive to dry heat, but if adequate protection be given against sunburn, satisfactory growth is made and good crops are produced although sunburning of the fruit is common.

Late spring frosts are a limiting factor in the mountain valleys of the foothill belt, occasional losses having been recorded in Placer County. Ordinarily such damage is confined to the trees on the bottom lands. Loss of the crop was reported at the Jackson sub-station in 1898 because of frost damage to the flower buds. Losses from this cause could undoubtedly be eliminated or greatly reduced by means of orchard heating such as is practiced with other deciduous fruits.

Rainfall

No data are available concerning the maximum and the minimum amounts of water required to grow the persimmon. In general it may be said that it requires at least as much as do other deciduous fruits grown in California. Experience in the southern part of the state, where the trees have been interset in citrus orchards, indicates that superior yields are obtained when amounts of water are used equal to those required for the citrus fruits. On this basis the water requirement may be said to range from 36 to 45 inches annually, including rainfall.

Wind

While the persimmon tree will withstand considerable wind, observations made on plantings in sections where fall winds occur frequently indicate that there is considerable loss through the scarring of fruit at about the time of maturity. If severe winds are experienced reduction in the quality of much of the crop is likely to occur. The use of windbreaks is recommended in regions where winds are prevalent and staking of young trees is important in districts where there are prevailing winds, however light.

Humidity

The persimmon is grown in California under a wide range of atmospheric humidity. Where the irrigation practice is good the trees produce crops even in extremely arid regions. Since fair crops are produced throughout the great interior valleys, humidity cannot be considered as of especial importance if other environmental conditions are satisfactory. However, in the coastal belt, particularly in the southerly part of the state, where fogs are more frequent and the humidity higher, the tree seems to thrive especially well, and here the largest tree growth is found. This is probably as much a result of the deeper soils and better cultural practices employed, however, as of differences in atmospheric humidity.
PERSIMMON DISTRICTS IN CALIFORNIA

As previously mentioned, the Oriental persimmon was widely scattered throughout California in the early days. Plantings, many of which still exist, were made in Butte, Napa, Solano, Placer, Tulare, Kern, Santa Barbara, Ventura, Los Angeles, Orange, and Riverside counties. In only a few regions, however, has any considerable expansion of plantings taken place. In northern California the principal persimmon-producing district is Placer County, while in southern California the main plantings are in Santa Barbara, Ventura, Orange, and Los Angeles counties.

In Placer County the development of persimmon plantings has been incidental to the more extensive plantings of shipping plums, pears, and grapes. The persimmon early proved its ability to withstand adverse soil conditions, and when other deciduous fruit trees died, particularly in the poorly drained and cold mountain valley bottoms, persimmon trees were planted in their places. The result has been that much of the persimmon acreage there is in small plantings, parts of or interplanted in other fruit orchards. The total acreage in Placer County planted to persimmons is about 125, according to the latest figures available. Many of the trees are situated on hillsides when the soil is shallow and where cultural practices are difficult. Under these conditions the trees have not made the growth which is attained under more favorable conditions, but they bear good crops consistently; in fact show a marked tendency to overbearing. Most of the northern California plantings were made prior to the Federal quarantine order prohibiting the importation of nursery stock, and the trees were obtained direct from Japan and are on kaki root. Nearly all of the orchards are of mixed varieties and the top-working of the seedlings and undesirable varieties would undoubtedly greatly improve the standardization and sale of the crops. While irrigation has been practiced on most of the plantings, no records are available relative to the amount of water used, which has been the same as applied to the other deciduous fruits.

The conditions in Placer County are typical of much of the foothill belt in the Sacramento and San Joaquin valleys and the success of the persimmon there affords reason for believing that the area which might be devoted to the raising of this fruit is extensive. The behavior of the trees at the Government Plant Introduction Gardens near Chico and in several other plantings located at lower elevations
in both the Sacramento and San Joaquin valleys, demonstrates that the persimmon can be grown wherever other deciduous fruits are grown. It is certain, therefore, that in California the limited development of persimmon culture to date is the result of causes other than unsuitable soil and climatic conditions.

In southern California, plantings have been made generally throughout the citrus belt, particularly in the coastal area. One of the oldest is that on the Elwood ranch in Santa Barbara County, previously mentioned. Much of the original orchard still remains, though a considerable part was washed away during a flood some years ago. The most extensive orchards are to be found in Orange and Los Angeles counties. The older plantings are quite commonly found interset with citrus trees—orange, lemon, grapefruit, and tangerines. Just how the practice became established is not known, but it has spread and the combination has been a satisfactory one. Excellent examples of this combination are to be seen in the G. W. Sherwood orchard at Fullerton, where grapefruit and persimmons have been interset and in the Richter grove at San Dimas, where both lemon and tangerine trees have been used. The rapid growth of the trees and the heavy production of fruit experienced in these orchards indicates that the Oriental persimmon responds well to the cultural practices given citrus groves.

In recent years, in all parts of southern California there has been a pronounced increase in interest in the growing of persimmons which has led to the setting out of many solid plantings. According to the latest figures available, about 400 acres of persimmons have been planted in southern California in the past four years, mainly located in San Diego, Riverside, Orange, Los Angeles, San Bernardino, Ventura, and Santa Barbara counties.

The future of the persimmon industry in some parts of southern California is rendered problematical by continued subdivision activities which have brought about greatly increased land valuations. These, together with the high valuation of land suitable for citrus culture, constitute a distinct handicap to the raising of persimmons in districts affected by these factors. If the growing of this fruit were limited to the same climatic zone as the citrus fruits, its production on high-priced land would not be accompanied by risks or problems uncommon to many other subtropical fruits. On the other hand, since the persimmon can be grown on large areas in other parts of the state, where land values and costs of water are much lower, the unlimited expansion of plantings in southern California would seem to be more or less hazardous.
While limited plantings in the Imperial Valley have indicated that crops can be produced there, and the experimental planting at the Government Farm at Bard is now coming into bearing and will soon afford more specific knowledge as to the behavior of the different varieties, there does not seem to be at the present time sufficient evidence to warrant the general assumption that persimmon culture can be profitably carried on in this valley in competition with other areas in the state. Further experimental plantings should be tried before extensive acreage is planted.

SOILS

Judged by its behavior in both California and the southern states, the Oriental persimmon is not particular in its soil requirements, apparently growing about equally well on a wide variety of soils, though the response the tree makes indicates some degree of preference. On the heavy adobes of Orange County and the deep, rather heavy loams of other parts of southern California, the tree reaches its maximum size, while on the lighter and especially on the shallower soils, the tree makes much less growth but comes into bearing earlier. This difference in response is partially attributable, however, to differences in cultural treatment.

It has been a common assumption that the persimmon is naturally resistant to excessive soil moisture and that therefore it is especially adapted to low, wet areas. This is true only of the native or *virginiana* root, which can withstand a higher water table, or periods of continuous wet soil conditions much better than other rootstocks. It should be emphasized, however, as will be adverted to later, that this root is not generally so satisfactory for the conditions in California as are the other stocks which are used. Neither the *kaki* nor the *lotus* root are tolerant of poorly drained soils, the former less so than the latter, and illustrations of failure to recognize this fact are not lacking in both northern and southern California where many trees have died from this cause. The difference in resistance between the *lotus* and the *kaki* is well illustrated on a grove in Orange County where on account of excessive irrigation and poor drainage the original planting of trees on *kaki* root has almost completely died out, while the few trees on *lotus* root have lasted much longer, although several have succumbed recently. The most ideal soil conditions for the optimum growth of this fruit are provided by a well drained, medium heavy loam, well supplied with organic matter.
PROPAGATION

ROOTSTOCKS

Three rootstocks have been used for the persimmon in California, the \textit{kaki}, \textit{virginiana} and \textit{lotus} species. The older plantings are almost entirely on the \textit{kaki} root since the trees were imported from Japan where the root has been almost exclusively used. In recent years some shipments of trees have been made from the southern states where the native or \textit{virginiana} stock has been favored. From the beginning of interest in persimmon planting a few trees have also been propagated on this stock by California nurserymen.

As a result of Meyer's observations on the use of \textit{Diospyros lotus} in China, this stock came into prominence some years ago and large importations of seed were made both by the United States Department of Agriculture and by private agencies. Importations of nursery trees on the \textit{kaki} stock continued to supply the majority of trees, however, until prohibited by Quarantine Order No. 37, which became effective on June 1, 1919. This order made it necessary for those who intend to plant to secure trees propagated in this country and resulted in a marked stimulus to the growing of nursery trees in California. Some importations have been made from the southern states, but the interception of the persimmon borer in some of the shipments has indicated the danger involved in so doing. The result has been that with the exception of some few trees imported from the southern states, all persimmon trees grown in California since the issuing of the quarantine order have been on the \textit{lotus} stock.

\textit{D. kaki}.—As has been stated, the oldest orchards in California are on this stock. Its habit of growth is to produce a long tap root with few fibrous laterals, in this respect resembling the walnut. These long tap roots are easily broken or injured in handling and shipping, are difficult to pack and in general have caused much dissatisfaction with this root on the part of nurserymen and growers. There is no question, however, that the stock makes a satisfactory union with all varieties at present grown, and produces fine orchard trees.

When the experience and practices of both the walnut and pecan nurserymen in the handling of trees with the same type of root are available, it is difficult to understand just why such practices have not been used in handling the \textit{kaki} root. In order to limit the length growth of the tap root and to stimulate the development of fibrous
laterals in the case of both the walnut and pecan the tap root is cut
while the trees are in the nursery row, a long-bladed spade being
used for this purpose. This practice gives very satisfactory results,
and it is believed that it is applicable to the kaki root, and that if
used, much better results could be obtained than have been in the
past.

The kaki root is not as resistant to excessive soil moisture as either
the lotus or the virginiana. The kaki is not as susceptible to crown­
gall attack as is the lotus and this quality is reviving interest in a
possible resumption of its use. Further, it is reported that one of
the most widely used stocks in Japan and parts of China is a wild
form of D. kaki which is said to be very hardy. This form was intro­
duced some years ago by the United States Department of Agricul­
ture, but was lost before it received widespread distribution. What is
believed to be the same form has recently been introduced again and
is being propagated for further trial. Efforts are also being made
to locate a large supply of this form. The few trees of this rootstock
now growing at the Plant Introduction Garden at Chico seem to be
more resistant to crown gall than lotus stock growing nearby. They
are vigorous and thrifty and give decided promise of affording an
excellent rootstock.

D. virginiana.—In the southern states the wild native American
persimmon early came into use as a rootstock and soon demon­
strated its superiority over the kaki root for the conditions in that
region. It was found to be adapted to a much wider range of soil
conditions, and trees on this stock showed superior growth. Its
habit of growth is to produce many fibrous roots which make it easier
to transplant than the kaki. In the opinion of H. H. Hume this
stock is the best root for the Oriental persimmon in the south. It has
the disadvantage of suckering badly, however, particularly if the
roots are injured. Trees on this stock have grown well in California,
both those imported from southern nurserymen and those grown from
seed here. It has been the experience in this state, however, that it
is difficult to get a uniform stand of nursery tree from this root.
Trees on this root will stand unfavorable soil conditions, and par­
ticularly excessive moisture, much better than on either of the other
two stocks. In Placer County J. A. Teagarden reports that the use
of this stock in the low and colder parts of his orchards has delayed
the blooming period of the trees about thirty days in the spring, thus
insuring freedom from frost injury. In poorly drained areas where
water may stand for considerable time during the rainy season, this
root has also been found to produce better trees.
D. lotus.—Although this is the newest stock to be used for the propagation of the Oriental persimmon, *Diospyros lotus* has rapidly superseded all others in California. Meyer\(^{12}\) reported it as the stock upon which he found the oldest topworked trees growing in northern China. Trees were observed which he estimated to be several hundred years old. The use of this rootstock was suggested in 1882 in the Report of the California Agricultural Experiment Station,\(^{13}\) which stated that it was superior to the *virginiana* because of the better root system which it produced. The *lotus* stock has produced the most thrifty, rapidly growing, uniform stands of nursery trees of any stock yet tried in California and this rapidity of growth has been maintained by the young orchard trees. It produces an excellent fibrous root system, does not sucker and is easily handled in the nursery. The greatest drawback of the *lotus* stock is its susceptibility to infection by crown gall, which has become so widespread in recent years as to constitute a serious menace to the continued use of this stock. Nurserymen are, therefore, looking for a strain of this stock that will possess its good qualities but in addition will be resistant to this disease.

The *lotus* stock is more resistant to drouth conditions than the *virginiana* and probably the *kaki*. It will not withstand poorly drained soils, but as this is an exceptional condition in most parts of California, it can be recommended generally for planting except where crown-gall infection is known to exist.

**Seeding**

Seed of the *lotus* may be planted either in flats or in field beds if the latter are shaded from the direct rays of the sun and covered to keep the birds away. The usual practice is to stratify the seeds in sand in the fall, covering them with about an inch of sand which is kept moist until early spring when they are planted in nursery rows or in flats. Some nurserymen plant them in the spring without stratifying, using a mixture of half sand and half soil. The flats should be kept in the partial shade of a lath house, or the beds should be shaded, until germination is complete, as the seedlings are very susceptible to sunburn. If planted in field beds, the seedlings should be thinned to a distance of eight inches in the row, and in transplanting:


\(^{13}\) Klee, W. G. The *Diospyros lotus* or so-called Italian persimmon. Report of the Col. of Agr., Univ. of California 1882:102–103. 1883.
ing from flats this distance should be maintained. Shade must be provided for all newly transplanted seedlings until they become well established and growth has commenced. For this purpose shingles are frequently used (fig. 12) while lath screens are also employed.

![Shading seedlings with shingles](image_url)

**Fig. 12.**—Foreground, shading young seedlings by means of shingles. Background, young grafted trees recently staked.

In general the same methods are used in the handling of kaki seed. Where possible the seeds should be stratified soon after removal from the fruit. Where drying has occurred they should be soaked in warm water for two or three days before stratification.

**Grafting**

Most of the nursery stock grown in California has been propagated by grafting, either bench-grafting or in place in the nursery row. The ordinary whip or cleft grafts are used, the former giving a somewhat better union, though the trees produced by either method are satisfactory. Seedlings of one or two years growth are used. If the whip graft is to be employed the top is removed by a sloping cut
about an inch in length, and a scion from the previous season's growth of about the same diameter as the stock, and having two buds, is prepared. A long sloping cut is made at the base of the scion similar to that made on the stock and the two are fitted together by means of incisions in both stock and scion in the manner illustrated and described by Fletcher\(^{14}\) or in any standard text on propagation.\(^{15}\) If the seedlings are to be cleft grafted, they are cut off squarely just above the surface of the ground and are then split with a sharp, strong knife. The scions should be taken from well matured wood of the previous year's growth, with two buds. The lower portion of the scion is cut so as to form a long wedge with one edge thicker than the other. The cuts are made so as to have the lowest bud at the top of the wedge. In order to insure contact of the cambium layer of the scion and the stock, the former is tilted outward slightly so that the lines of the two cambium layers cross. The scion is firmly tied with strong cotton cord and the wound and union covered with grafting wax. After growth starts, all suckers arising below the union should be removed so as to force all growth into the scion. This method can be used with advantage on stocks that are too large to be readily whip grafted.

**Budding**

The propagation of the Oriental persimmon by budding is not ordinarily practiced. The experience has been that this method of propagation does not give a satisfactory percentage of stand or the uniformity of growth desired by the nurserymen. J. E. Morrow, of the Government Plant Introduction Garden at Chico reports recently, however, much greater success from the use of buds removed by out-lining or cutting through the bark only and peeling it off, rather than cutting through and taking a part of the wood. This procedure gives much more cambium surface and should produce much better results.

Budding may be done in the spring as soon as the sap is good and the bark slips readily or in the fall before the sap flow has ceased. The buds are taken from the previous season's growth. Where seedlings of the current season are to be used, budding usually must be delayed until early fall to permit them to become large enough.

The ordinary "T" incision is made from two to three inches above the surface of the ground, the vertical cut being about an inch and


a half long. The bud is cut with a shield of from one and a quarter
to one and a half inches long and is gently forced down into the
incision until the shield is entirely beneath the flaps of bark. A
narrow strip of budding cloth one-quarter to three-eighths of an inch
wide is used for wrapping. This is started above the bud and wrapped
downward. As soon as the buds have united with the stock the
wrapping should be cut. When growth begins, the stock should be
cut off just above the bud, and stakes provided as soon as the new
shoot is long enough to tie. The method of budding the native per­
simmon has been well described and illustrated by Fletcher. Meyer16
reports that the varieties in northern China are ring-budded on the
lotus root. This method is also described by Fletcher.

Regardless of the method used, staking and tying should com­
mence when the scion or bud has made a growth of from twelve to
fourteen inches (fig. 12). This will protect the buds from being
broken by wind or other means, facilitates cultivation and irrigation,
and develops strong and straight trees. Ordinary building laths are
satisfactory for this purpose.

**Topworking**

Reference has already been made to the desirability of topworking
many of the trees in the older plantings in California as a means of
eliminating inferior varieties and for the purpose of promoting
standardization of packs. Trees to be topworked should be cut back
in late winter. The branches to be grafted should be selected so as to
form a desirable framework and should be cut back to stubs from 18
to 24 inches long. Several should be left uncut to act as nurse limbs
until the scions have grown for a year or two. The ordinary cleft
graft is employed (fig. 13) the number of scions being two or more,
depending upon the size of the limb to be grafted. In the case of
large stubs it is an advantage to use more scions than are needed
since they encourage rapid healing over of the wound. The scions
should be from three-eighth to one-half inch in diameter with two
or three strong buds. The wounds should be kept waxed until they
are completely healed over. After a year or two all scions but one
to each limb can usually be removed, since the healing of the cuts will
have progressed far enough. The trunk and crotches should be kept
whitewashed until the new top is grown, as a means of preventing
sunburn.

16 Meyer, Frank N. Agricultural explorations in the fruit and nut orchards
For the purpose of keeping birds from breaking out the scions by perching on them when first inserted, paper bags should be inverted over the stubs and tied, and holes cut to provide air circulation. The growth made by scions on large trees is rapid and there is danger that the new branches will break out at the union unless they are braced. This may be accomplished by lashing a strong 1 by 2 inch upright to
to the old limb and tying the new limb to it until the union becomes strong enough to maintain the additional weight. It is usually necessary to head back the vigorous growing scions to prevent the new limbs from becoming willowy and to cause them to branch.

Fig. 14.—A bud variation in the Hachiya variety. A, The standard type. B, The variant form. Courtesy A. D. Shamel, United States Department of Agriculture.

**Bud Selection**

In the propagation of nursery stock and in the topworking of old trees, care should be used in the selection of buds and scions. The occurrence of occasional bud variations has been noted in many fruit varieties and there is some evidence to indicate that such have occurred in the persimmon. Thus, in the Hachiya variety there has occasionally been found a rounded form on trees which produce mainly normally shaped fruits (fig. 14). It would, therefore, seem desirable to select budwood while the fruit is still on the trees, although the
hazard from not so doing would appear to be slight. It should be emphasized in this connection that Hume has shown that in many persimmon varieties pollination has a decided effect on the size and shape of the fruits. Since these are two of the important characters used in bud selection, it is necessary that they be considered in connection with the selection of buds or scions. The presence of seeds frequently causes a reduction in size of the fruit, which may explain in part the difference in size previously noted in fruits of the Hachiya variety, as grown in northern California and southern California, the older orchards in the north invariably containing a number of varieties and usually producing seeded fruit, while in southern California most of the plantings contain but the one variety and the fruits produced are seedless. In some varieties the presence of seeds alters the shape from conical to oblate or flattened. There is obviously, therefore, always the likelihood that suspected bud variations may be nothing more than the normal result of seed development. There has been no systematic work done on this phase of persimmon culture in California and no specific recommendations can be made. The general policy of selecting budwood from trees producing good crops of uniform fruits, typical of the variety under normal orchard conditions, should be followed until there is more specific information available.

ORCHARD MANAGEMENT

PLANTING AND CARE OF YOUNG TREES

Planting distances.—Planting distances vary with the variety and with soil conditions. In northern California on the shallower soils of the hill slopes, a distance of 15 by 15 feet has not resulted in crowding, while in southern California on some of the deep, rich soils, trees planted 24 by 24 feet have eventually crowded each other. There is strong evidence to indicate that under these conditions a distance of 30 by 30 feet will probably not be too great for strong-growing, spreading varieties such as the Hachiya and the Tamopan. The Hyakume is more slender and upright in its growth and can be planted at a distance of 20 by 20 feet under most conditions.

Interplanting.—It has been the practice to interset persimmon groves with citrus trees in southern California as the usual distance of citrus plantings, 24 by 24 feet, and in general this arrangement has proved very satisfactory. On at least one interplanted orchard

where a smaller distance was used the trees have become too crowded, the fruit being produced in the tops almost entirely, and the yield materially reduced. For plantings on soils of moderate depth and of good quality in both northern and southern California a distance of 24 by 24 feet on the square system is recommended for the Hachiya and Tamopan varieties, and 20 by 20 feet for the Hyakume and other varieties with a slender, upright habit of growth.

Fig. 15.—Left, well pruned tree with desirable framework. The distribution of scaffold branches is good. Right, poor framework formation. This will give trouble later. See also figure 16.

Holes 2 feet square and 3 feet deep and the use of top soil for filling in around the roots are recommended. Blasting the holes in shallower soils has given good results in Placer County. All broken or torn roots should be pruned off and the cuts disinfected with bordeaux paste or bichloride of mercury solution. The trees should be headed back to a height of from 30 to 36 inches and the main framework branches developed from the best spaced four or five shoots produced on the upper 15 to 18 inches of the trunk (fig. 15).
Irrigation should follow the planting of the trees, even though the soil is moist, in order that it may be thoroughly settled around the roots. While not absolutely necessary, it is an advantage to whitewash the trunks of young trees to prevent sunburning, especially in regions where summer temperatures are high. Wrapping with newspaper will serve the same purpose, provided there is sufficient air space between the paper and trunk. Where the growth of young trees is very rapid, as is often the case, staking is necessary for the first two or three years, as the trees are willowy and easily blown over.

Pruning.—Pruning of young trees should be conducted with a view to developing a strong framework capable of carrying heavy crops (fig. 16). After the four or five main framework limbs have been selected, other growth below them on the trunk should be suppressed. After the first season the limbs should be cut back from
a third to a half, according to the amount of growth, and after the second season, pruning should be such as to direct the growth and strengthen the framework branches. A minimum of pruning is to be recommended at all times and after the second season little more than the removal of cross limbs, or the heading back of unruly leaders is generally required. It has been observed frequently in young orchards that continued drastic pruning delays the fruiting period and stimulates excessive vegetative growth, the result being added care with smaller returns. For the first three or four years fruits should be removed if they fail to drop naturally. The strength of the trees should go into the development of framework parts during the early years if excessive loss through breakage is to be avoided later.

Irrigation.—Irrigation to insure steady and uninterrupted growth should be provided throughout the dry growing season, the interval being determined by the results of an examination of the soil with a soil auger or some other means of disclosing the condition of the subsoil. If a good top soil is used in filling in around the roots of the young trees, no fertilization will be required, though where the cost of water is not too high, the growing of cover crops during this period is recommended.

**CARE OF BEARING TREES**

**Tillage operations.**—The cultural practices followed are in general similar to those employed with other deciduous fruits, no special departures being required by the persimmon. One plowing a year, usually in the spring, is the common practice. This keeps the roots below the surface six-inch mulch with consequent less exposure to variation in extremes of heat and dryness. If a winter cover crop is grown, spring plowing should be done early enough for the green matter to become thoroughly incorporated in the soil while there is still moisture enough to bring about immediate decay and availability. Cultivation sufficient to keep down weeds and to leave the soil in good condition to take water is all that is required, once after each irrigation being the usual practice.

Irrigation.—The amounts of irrigation water applied vary notably in different parts of the state. Actual measurements on orchards are difficult to obtain in northern California. In southern California as much as three acre inches a month during the growing season is used on some of the orchards, especially those interset with citrus trees. On most soils two acre inches a month is probably sufficient. While
monthly irrigations are sufficient in the deeper soils of both northern and southern California, more frequent irrigations, using smaller amounts of water are needed on the shallow hillside soils because of the reduced water-holding capacity. The furrow method is most commonly used; however, in a few orchards on sandy soils, the basin system has given most satisfactory results.

The use of the soil auger, or some similar means of examining the condition of the soil beneath the surface is indispensable in good orchard management, in order that the application of water may be uniform, adequate and properly timed. During the winter months, irrigation may be necessary during years of light rainfall, as is the case with other deciduous fruits.

The relation of adequate soil moisture to the quality of the fruit produced is well demonstrated in some districts by the correlation which has been observed between the sunburn or blackening of the fruit and insufficient water supply. Orchards with the same soil conditions and sufficient moisture exhibit little of this difficulty. It is especially important that water be supplied during the last two or three weeks of the ripening period, as there seems to be a relation between the size of the fruit and the presence of ample moisture during this period. Insufficient moisture at this time seems to result in small fruit, even though conditions have previously been favorable.

Fertilization and cover crops.—There is no uniform practice in the application of fertilizers, although the importance of organic matter in the soil is generally recognized. In some of the northern California districts an annual application of manure is practiced, although many of the orchards are not fertilized at all. In southern California where many of the orchards are interset with citrus trees, the regular citrus orchard fertilization practice is followed; namely, the application of from one to two pounds of nitrogen to a tree a year. The best results seem to occur where at least half of the nitrogen is secured from bulky organic matter. In the absence of any systematic tests, the superior results obtained from the fertilization program just mentioned, indicates that the general practice is a satisfactory one.

Since California soils are in general deficient in organic matter, persimmon trees in common with other varieties of fruit trees undoubtedly profit by the regular application of bulky manures and coarse, leguminous materials such as bean and alfalfa straw, and the growing of summer and winter cover crops where this is possible. Purple vetch, *Melilotus indica*, and horse beans are used for winter cover crops in southern California, purple vetch being the most popular. Where there is adequate water at a low rate during the
summer months, the perennial sweet clover, *Melilotus alba*, furnishes an excellent, deep-rooted cover crop, especially adapted to breaking up heavy subsoils. Cowpeas are also used as a summer cover crop.

**Pruning.**—Persimmon varieties vary notably in their habit of growth and pruning practices should be adapted to these varietal characteristics. The Hachiya is a broad, upright growing, almost ideal orchard tree, somewhat spreading in habit but with strong, supporting framework, and therefore it requires little pruning. The Tamopan is similar, though inclined to a somewhat more willowy habit of growth. On the other hand, the Hyakume tends to the development of a strong central leader with rather short, drooping laterals.

In general, the pruning of bearing trees should be limited to the renewal of the fruiting wood. Since the fruit is borne on the growth of the current season, sufficient thinning should be given to insure vigorous growth each season from the secondary scaffold branches. Because of the general tendency toward vigorous growth, care is required to thin sufficiently to admit light to the interior. If this is not done, the interior fruiting wood dies, and all the crop is borne on the outer parts of the tree. The possibilities of the crops are consequently materially decreased, and the danger of breakage is augmented. All cuts should be made to laterals so as to avoid heading or "stubbing," which is very objectionable. Water sprouts on the trunk and main branches should be rubbed off except where they are needed to fill in spaces opened by breakage. Excessive cutting and "stubbing" results largely in the production of vigorous vegetative growth and failure to fruit. Old, neglected trees can be rejuvenated by a rather vigorous thinning and cutting back to laterals and by shortening the main branches to force out laterals where, through long neglect, all interior fruiting wood has disappeared.

**Thinning.**—Many persimmon varieties exhibit a marked tendency to alternate bearing. This seems more pronounced where pollination occurs than where the fruits are seedless. In southern California the very heavy drop that takes place throughout the growing season usually thins the crop sufficiently to insure large size in the remaining fruit. In northern California, where pollination and seed development are common, large crops of relatively small fruit alternating with smaller crops of fruit of fairly good size is the usual occurrence. It has been shown at the Chico Plant Introduction Garden that thinning increases the size of the fruits and reduces the tendency to alternate bearing. Since the market pays substantial premiums for large fruits, in all probability the operation would pay. No extended
experiments have been conducted on this practice, however, which constitutes one of the most important problems awaiting investigation. In the absence of specific information, it is recommended that the clusters be thinned to one or two fruits and that each individual fruit be given ample space for development. Each grower should determine for himself the optimum number of fruits of standard size and quality that his trees can carry and mature each season. It is believed that between three and four hundred fruits for a mature Hachiya tree is sufficient, though there are trees which under exceptional circumstances have produced as many as one thousand good fruits in a single crop.

Bracing and propping.—The wood of the persimmon is very brittle and propping is almost invariably required as the trees come into bearing (figs. 8 and 9). Much can be done to encourage the development of a strong framework by careful training and judicious pruning of the young trees, and this will save extra work in later years (fig. 16). Additional support by means of props is usually required, however, if danger of loss from breakage is to be avoided.

Several means of accomplishing this are employed by the growers. Propping alone, even though the poles are fastened at the top by wire clasps over the branches, is not entirely satisfactory. Winds may lift the branches and the props, if not fastened, fall, and if fastened, do not always come back in place with the result that the limbs break. A combination of wire bracing and propping is the most general practice. Wires are fastened with large screw eyes to, or are wrapped around, the main uprights and then dropped to the laterals and fastened in a similar manner, props being placed under the smaller laterals. The latter system is quite objectionable since it eventually leads to breakage of the wrapped branches.

Because of the habit of growth, the central ring wire bracing system used with peaches and other deciduous fruits is applicable without modification only to certain varieties, but adapted and supplemented with propping it can be used with advantage on practically all the commercial sorts. One of the successful methods consists of a series of wires dropped from the top of a 2 by 4 inch pole which has been erected in the center of the tree, and extends two or three feet above the top of the crown. The wires are passed around the limbs through sections of old hose, or leather bands are used to prevent binding. In large limbs, screw eyes may be used successfully, but are not advised for small branches because of the brittleness of the wood, which frequently results in breakage at the point of attachment. The advantage of this system lies in the smaller number of
poles necessary, thus aiding cultivation, irrigation, and picking operations. Because of their cost, props should be gathered up and stored during the winter.

Harvesting.—The determination of the proper stage for picking varies with the variety. The Hachiya should be picked when the pink tinge reaches the basal half at which stage at least one-third of the fruit surface is well colored. It should not be picked green. Much of the difficulty in marketing this variety on local markets has come from picking it too early. The Hyakume and the Tanenashi can be picked when the yellowish tinge extends almost down to the basal or calyx end. While observations on the Fuyu variety are more limited, it seems probable that it should lose almost all of the greenish appearance before it is picked. For home use the fruits can be left on the trees until they are fully colored, though there is danger of loss from bird damage. When well colored they can be picked and placed in a cool, dark place to ripen.

The fruit should be clipped from the trees with an orange type of clipper, the cut being made close to the calyx which is left attached to the fruit. The fruits should never be pulled from the tree. They must be handled very carefully to avoid bruises and injuries which later turn brown and lower the grade. Shallow boxes should be used in picking and transportation of the fruit from orchard to packing house. The Hachiya is particularly susceptible to injury because of the pointed apex and special care must be used in handling this variety.

PESTS AND DISEASES

The persimmon is particularly free from both serious insect pests and diseases in California, although a number of insect pests have been reported in foreign countries, some of which might become serious if introduced into California.

The citrus mealy bug, *Pseudococcus citri* (Risso), is becoming increasingly prevalent in southern California orchards. It attacks the fruit under the calyx and because of this protected position is exceedingly difficult to reach by sprays. Satisfactory control of this insect involves the elimination of the Argentine ant in order that the natural insect enemies of the mealy bug can function, which if unhampered usually keep it under control. Spraying of the trees during the dormant season with oil emulsion or crude carbolic-acid

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emulsion, with sufficient pressure to force the liquid into the cracks in the bark where the infestation is heavy is also of assistance in controlling this insect.

At least two borers attack the persimmon. In the southern states the persimmon borer, *Sannina uroceniformis* Walker, is the most serious insect pest in persimmon orchards and is a limiting factor in production in some districts. This pest is almost impossible to reach since it works inside of the trunk, tunneling upward. It has been intercepted in several shipments of nursery stock from southern states, although exceedingly difficult to detect without almost completely destroying the trees. Because of the danger of introducing this insect, importations from these states have been severely restricted and even prohibited in some counties in California.

The flat-headed borer, *Dicerca obscura* (Fabr.), attacks the tree in the southern states. Whitewashing the trunks to prevent sunburn and maintaining the trees in good vigor tends to reduce the occurrence of this pest. When once established in the tree, the only method of eliminating the borer is to dig them out with a knife or stiff wire.

Occasionally the red-humped caterpillar, *Schizura concinna* (A. & S.), is found attacking trees in California, and if uncontrolled sometimes defoliates them. Spraying with lead arsenate at the rate of two pounds to fifty gallons of water is recommended for its control.

Other insects occasionally found on persimmon trees in California include the soft brown scale, *Coccus hesperidum* Linn., the black scale, *Sassettia oleae* (Bern.), the San Jose scale, *Aspidiotus perniciosus* Com., the barnacle scale, *Ceroplastes cirripediformis* Com., and the oyster shell scale, *Lepidosaphes ulmi* (Linn.). In Florida the twig girdler, *Oncideres cingulatus* (Say), the white peach scale, *Aulacaspis pentagona* (Targ., and the citrus white fly, *Lialeurodes citri* (R. & H.), in addition to several of those already mentioned, attack the tree, the twig girdler being especially serious.

The nematode has been reported on injured persimmon roots but apparently the persimmon is not very susceptible to this pest. R. R. McLean, Horticultural Commissioner of San Diego County, has made a study of persimmon roots and fig roots in a soil area heavily infested with nematode at Point Loma. No infestation of the persimmon roots was found even when intertwining with fig roots which were badly infested.

In foreign countries there are several insect pests of major importance that have thus far not gained entrance into this country. The most dangerous of these is the Mediterranean fruit fly, *Ceratitis capitata* (Wied.), which has caused extensive damage in persimmon
plantings in Australia. In Japan the larva of a moth, *Kakivoria flavofasciata* Nag., somewhat similar to the codling moth of the apple, causes serious injury in some persimmon growing districts. The importance of rigid quarantine restrictions to prevent the introduction of these insects into the United States cannot be overestimated.

In Imperial and Coachella valleys a cicada, *Tibicen cinctifera* (Uhler), does considerable damage (fig. 17). These insects emerge from June to September and attack the fruit as it nears maturity. Dates are protected from its attack by means of bags. Should the persimmon ever become commercially important in these sections, similar protection may be required.

![Fig. 17.—Injury caused by cicada, *Tibicen cinctifera* (Uhler), in the Imperial Valley. It has not been observed as yet in other parts of the state.](image)

*Crown gall.*—Crown gall, caused by the organism *Bacterium tumefaciens* S. and T. is the most serious disease that attacks the persimmon tree. As has already been noted, it seems to be more prevalent on the roots of the *lotus* stock. There is some doubt as to whether all of the rough and warty growth found at the bud union on nursery trees on this root is caused by this disease. This problem is now under investigation at the Citrus Experiment Station. Young trees should be carefully inspected before planting, and the roots examined to detect cuts where galls may have been removed before shipment. Large galls around the crown may be cut away, the wounds sterilized with corrosive sublimate solution of a strength of 1:1000 and then covered with asphaltum paint. Usually the galls are scattered over the roots so that complete removal is not possible. The remedy lies in planting clean trees.
FRUIT SHEDDING

The shedding of immature fruits by both young and old trees is a common phenomenon and one that frequently causes concern. The causes of the dropping are not clearly understood since no thorough study has been made of the problem in California. In Florida, Hume has demonstrated that fruit drop is closely associated with lack of pollination. While this may have a bearing on persimmon dropping in California, the fact remains that in most parts of the state, satisfactory crops are regularly produced without pollination and seed formation.

During periods of extreme heat and low humidity the loss of moisture from the foliage is excessive. At such times water may be withdrawn from the fruits and the periodic occurrence of this phenomenon may lead to their dropping. This has not been demonstrated with the persimmon, but the work of Coit and Hodgson\(^{19}\) has established this relation between sap withdrawal and June drop in the navel orange. The maintenance of an adequate soil moisture supply during the growing season, and especially during periods of hot weather, is calculated to reduce the likelihood of loss from this cause and moreover is good orchard practice.

On the other hand, the moderate dropping of fruits in mature orchards which are properly cared for is a desirable condition and obviates the necessity of thinning. It has been noted that the number of fruits remaining is usually all that the tree can properly mature if adequate size is attained. This is particularly true in southern California where most of the fruits are seedless. In northern California much if not most of the fruits are seedy, and the problem is usually one of too heavy crops, fruit-drop not being an important factor in that district (figs. 8 and 9). It is probable that, as in the case of the citrus fruits in regions where excessive fruit shedding occurs, the application of quickly available fertilizers in early spring will be found to be beneficial.

USES OF THE FRUIT

Utilization Fresh

The persimmon is preeminently a fruit for consumption while fresh. It is most commonly served when soft, the pulp being spooned out and eaten as a dessert, with or without fresh cream. It makes an attractive and delicious ice cream. When peeled, the large red-fruited varieties, particularly the Hachiya served whole, make a delectable fruit salad on lettuce, with French, cream, or mayonnaise dressing. Non-astringent varieties can be eaten hard and are used for dicing in fruit salads in much the same manner as are apples.

One of the drawbacks to the increased use of the persimmon at the present time is the difficulty of determining the proper stage of ripeness at which to gather the fruit. When ready for eating the astringent varieties are too soft to be carried safely very far. The best practice is to purchase them when firm but well colored and to hold them for a few days until fully ripened. The increasing popularity of the Fuyu variety is due particularly to its non-astringent character even when hard. It can be transported readily and can be eaten at any time after it begins to color. This variety will undoubtedly prove to be one of the most popular sorts when produced in sufficient quantity so that the buying public may become acquainted with it.

Processing

In order to overcome the disadvantage of astringency in the fruits, the Japanese long ago worked out methods of processing them. The first which came to the attention of California growers, reported in 1877,20 consists in subjecting the unripe fruits while still hard to the fumes of alcohol by placing them in tubs recently emptied of saké or rice beer. The fruits are left in these tubs from five to fifteen days, depending upon the variety and temperature, and when removed are entirely non-astringent though still hard. This method was first tried in California in 1905 by Roeding21 of Fresno at the suggestion of the United States Department of Agriculture. The experiment was entirely successful; after eleven days the fruit was removed still hard but non-astringent.

McClure\(^2\) has recently reported two other methods developed by the Chinese for removing the astringency of persimmons. One of these, known as the lime-water method, consists in placing the fruits in large earthen jars and covering them with a solution of lime-water, one part by weight of lime to ten of water. The process requires from two days to a week or more, depending upon the variety, stage of maturity, and the length of time between harvesting and processing. On removal the fruits are non-astringent and juicier but still firm and are covered with a white bloom-like coating of lime which the merchants are careful to preserve. Fruits treated by this process are said to have better keeping quality than those ripened on the trees or in other ways.

Another method said to be in common use in China is that known as smothering and may be applied in one of several ways. That most often employed consists in placing an upright bamboo cylinder of open weave in the center of a large earthen jar in which the fruits are packed. A large stick of incense is burned in the bamboo cylinder and the smoke is said to bring about or to assist in the removal of the astringency. The method is said to act rapidly, requiring only one or two days to give satisfactory results. Fruit processed in this manner, however, must be consumed within a few days.

Considerable work has been done on this subject in the United States, notably by the United States Department of Agriculture\(^2\), \(^3\) and the Alabama Agricultural Experiment Station,\(^4\) both of which have devised new and improved methods for bringing about the loss of astringency in persimmons. It was early shown that the Japanese process depended for its efficiency on the alcohol contained in the sake. Carbon dioxide was found to give good results with fruit subjected to it from three to five days. Preliminary tests have shown that ethylene gas is also effective in removing the astringency. While the fruit can be rendered entirely non-astringent by these as well as other treatments, the shipping quality is usually impaired.

These studies strongly indicate that the sale of processed persimmons will necessarily be limited to local markets and those within rather short shipping distances. Thus far, no attempt has been made in the United States to sell processed fruits commercially. Whether

the use of such fruit could be popularized is purely a matter of conjecture. The introduction and propagation of such varieties as the Fuyu which do not require processing, would seem to be much the more promising procedure. For those who desire to process fruits for home use, immersing them for a period of twelve hours in water maintained at a temperature of 75 to 105 degrees Fahrenheit is recommended. Injuring the fruit by mechanical means, such as cutting into the center with a knife blade or pricking with a large needle, will also hasten ripening and usually with no attendant decay.

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**Fig. 18.—Method of drying persimmons employed in China. Courtesy C. C. Thomas, United States Department of Agriculture.**

**DRYING METHODS**

Dried persimmons are used extensively in both China and Japan. The less juicy varieties, such as the Tanenashi, are usually prepared in this way, as are also a number which are never suitable for eating fresh because of their excessive astringency. The fruits are cut from the tree, leaving a “T” shaped portion of the twig attached, which serves to attach them to the long strings into which they are braided after being peeled. These are then hung in the sun and wind for about three weeks, or in open sheds (fig. 18). After drying they are
cured in piles covered with mats where they undergo a sweating process, during which a coating of grape sugar forms on the surface. They are then ready for consumption. A description of the methods employed is given by Meyer26.

Both Japanese and American growers in California have dried persimmons for home use but only a fair quality of product has been obtained with the Hachiya variety and small dark-fleshed varieties. No attempts have been made to produce them commercially, however, although experiments conducted by the United States Department of Agriculture27 have shown that they are readily dried in an evaporator at a temperature of 122 degrees Fahrenheit. The fruits were peeled with nickle-plated knives to prevent the staining caused by iron blades. They were then sliced at right angles to the axis, and gave what was said to be an excellent light-colored product. The Tanenashi variety was found to be particularly well adapted for drying.

Investigations in progress by the Division of Fruit Products of the University of California have brought out the following points of importance in relation to drying persimmons:

1. The fruit should be dried when firm ripe, as when soft ripe it is mushy to handle and sticks to the trays.
2. Steaming before drying prevents darkening of the natural color during drying.
3. Sulfuring to retain color is not advisable as it causes the fruit to retain its astringent taste, which otherwise disappears entirely during drying.
4. Peeling causes the fruit to dry more rapidly and gives a more tender orange-colored product, but because of the labor and the loss in weight involved it may not be economically advisable.
5. Whole fruits dry very slowly, while sliced fruits stick to the trays. Halving the small fruits and quartering the large ones is believed to be the best procedure. The best product is that which is peeled and then sliced before drying.
6. Rapid drying in a modern dehydrater with a strong blast of air has given the best results. There is some darkening of color, but the orange-brown color is rich and not displeasing to the eye. The drying ratio of unpeeled ripe fruit is about 4 to 1.

Further studies will be required, however, before the possibilities along this line can be fully determined.

MARKETING

Principal Markets

At present the principal markets for the persimmon are New York and Chicago, Hawaii, and the local markets in California. Most of the northern California fruit is shipped to eastern markets, although some goes to Hawaii, while most of the southern California crop is consumed locally, eastern shipments being much smaller than those from northern districts. Since few or no markets can absorb car-lot shipments, the general practice of the growers in Placer County is to ship in mixed cars with plums, grapes, pears, and other fresh fruits. The bulk of the shipments is sold through fruit auctions. In southern California the fruit is usually sold to jobbers in Los Angeles and until recently has been handled on consignment. Because of the wide price fluctuation in spite of the rather limited amount of fruit, the leading growers, controlling the bulk of the acreage and crop during recent years, have set and maintained a price for their fruit through the medium of the Persimmon Growers Department of the Southern Counties Farm Bureaus. These prices are based on fruit graded and standardized as to pack.

Grading and Packing

Lack of standardization of pack and the absence of well recognized grades have greatly handicapped the growers in marketing their crops. Efforts have been made to induce the growers to ship only the best fruit, but these efforts have not been wholly successful, and markets still receive and handle much inferior and poorly graded fruit. This condition has reacted to lower the price of the better grades and undoubtedly has injured the reputation of the persimmon as a table fruit. For the purpose of improving this situation certain grading and packing standards have recently been adopted by the members of the Persimmon Growers Department of the Southern Counties Farm Bureaus. They apply only to the Hachiya variety, which is marketed in greatest quantity, and are as follows:

First Grade.—Fruits uniform in shape and color for the variety, free from all blemishes and sunburn, and packing not more than 6 x 8, that is, 48 fruits to the standard single tier, peach crate. The preferred pack for this grade is 5 x 7.
Second Grade.—Fruits eliminated from Grade No. 1 because of lack of uniformity of shape, discoloration or sunburn, or lack of size, but free from decay and serious bruising. Size should exceed half that standard for the variety.

Third Grade.—Culls. Fruits below the requirements of Grade No. 2.

The standard peach crate containing two layers of fruit when packed is the most commonly used package in northern California (fig. 19). It weighs from 18 to 25 pounds packed, according to the size of the fruit. A single tier box, weighing about 14 pounds when packed, is also used for larger fruit. For loose fruit the 30-pound lug box is used most commonly in southern California, while for shipment the single tier box containing from 20 to 48 fruits, according to size, is employed (fig. 20). Four-basket peach crates are used in Florida and other southern states. This package has also been used to a limited extent in Placer County shipments. The single tier crate is to be preferred for the Hachiya variety on account of the lessened degree of injury caused by the pointed shape of the fruit. The Hyakume, Fuyu, and other varieties do not have this handicap.

Fig. 19.—Two-layer peach crates used for express shipments in Placer County.
for eastern shipment is wrapped in paper, though there has been some evidence to indicate that wrapping may slightly retard ripening. It permits a more solid pack and prevents contact between the fruits.

Fig. 20.—Packing shed in southern California showing single tier method of packing.

COLD STORAGE

Much fruit has been placed in cold storage to be held for the Christmas market, particularly in Los Angeles. In some seasons the results have been far from satisfactory. The losses seem to have been caused principally by lack of uniformity in maturity and unfavorable temperatures. Some preliminary cold storage studies have been made at the California Agricultural Experiment Station, the results of which, according to Condit,\textsuperscript{28} indicate that all varieties softened much more quickly at 36 degrees Fahrenheit than at 32 degrees, and that the fruits keep best at 30 degrees. Most varieties show a tendency to shrivel in storage, especially at the apex, which might be overcome at least in part by the use of wrapping paper. Table 3, taken from California Agricultural Experiment Bulletin 316, shows the comparative results with the different varieties.

TABLE 3
LENGTH OF TIME IN DAYS IN WHICH THE FRUIT KEPT IN GOOD CONDITION

<table>
<thead>
<tr>
<th>Variety</th>
<th>County</th>
<th>32° F</th>
<th>32° F</th>
<th>35° F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hachiya</td>
<td>Placer</td>
<td>158</td>
<td>89</td>
<td>51</td>
</tr>
<tr>
<td>Hachiya</td>
<td>Orange</td>
<td>141</td>
<td>63</td>
<td>34</td>
</tr>
<tr>
<td>Tanenashi</td>
<td>Placer</td>
<td>170</td>
<td>98</td>
<td>30</td>
</tr>
<tr>
<td>Maru</td>
<td>Placer</td>
<td>210</td>
<td>189</td>
<td>63</td>
</tr>
<tr>
<td>Hyakume</td>
<td>Placer</td>
<td>210</td>
<td>148</td>
<td>63</td>
</tr>
<tr>
<td>Mikado</td>
<td>Placer</td>
<td>210</td>
<td>118</td>
<td>30</td>
</tr>
<tr>
<td>Tsuru</td>
<td>Orange</td>
<td>103</td>
<td>44</td>
<td>28</td>
</tr>
</tbody>
</table>

The best keeper in the 32 degree room was Atago, obtained from Chico under S.P.I. No. 13842. It kept 157 days in excellent condition, retaining its firmness and glossiness throughout. Specimens of the Tamopan from two different localities showed poor keeping qualities at all three temperatures. The problem of cold storage for the persimmon has not been solved and needs further investigation.

YIELDS AND RETURNS

The recent heavily increased planting of persimmons in California has undoubtedly been caused by the uniformly good returns that this fruit has brought over a long period of years. The average to the growers has been from 6 to 7 cents a pound for many years, but during the last three or four years it has reached as high as from 12 to 16 cents for choice fruit and as high as 20 cents a pound for extra fancy fruit. The price set by the Persimmon Growers Department of the Southern Counties Farm Bureaus for the 1924 crop was 9 cents F.O.B. the ranch for No. 1 grade and 7 cents for No. 2 grade. With the new acreage that is rapidly coming into production, these prices cannot be expected to continue, though with education, advertising, and improvement in grading and packing, the average price that has been received for many years should be maintained. In the opinion of one of the leading growers in Placer County, persimmons can be grown in that district profitably at 5 cents a pound to the grower.

According to the 1920 census, the average production to a tree for the United States was 50 pounds, while that for California was 75 pounds. These figures take into consideration all varieties and all kinds of orchard conditions and are below the yield of well-kept orchards of standard varieties. An average yield of 150 to 200 pounds
of fruit to a tree a year is a reasonable expectation. Some orchards exceed this at the present time. Under good care 80 per cent of first grade fruit ought to be received. Higher yields than this should not be used as a basis for estimating probable returns. Extreme cases can always be found, such as that illustrated by a tree on the Skeele place in Monrovia, set out in 1889 by W. N. Monroe, founder of the city. For three or four consecutive seasons this tree has yielded about 1000 pounds of fine quality fruit. It is, however, located at the edge of a citrus grove, with much free space around it, and receives excellent care.

Using an average production of 175 pounds of fruit to a tree and 80 per cent of this amount of first grade, with the trees set 24 by 24 feet, or 75 to the acre, the quantity of first class fruit would be 10,640 pounds; with the trees set 20 by 20 feet or 108 to the acre it would be 15,120 pounds to the acre. At 5 cents a pound gross to the grower, the gross returns to the acre would be $634.40 and $746.00, respectively. These estimates seem high in relation to a cost of production, which is much lower than in the case of the citrus fruits, but it must be remembered they are based on data secured on a relatively small acreage. The doubling and trebling of the acreage which has occurred in recent years will probably have a material effect on the prices received by the growers, unless concerted efforts are made to produce only the best quality fruit and to educate the buying public to the uses of the persimmon. The removal of the lower grades from the markets and disposal of them in other ways will doubtless be of assistance in this connection.

OUTLOOK

It should be pointed out that there are thousands of acres of land in California that are suitable to persimmon culture, much of this land being cheaper than that now devoted to the production of this fruit, particularly in southern California. In addition there are hundreds of thousands of acres of cheaper land in the southern states that can be put into persimmon orchards, with the advantage of closer markets, cheap labor and lower taxes. A continued high return for persimmons will not only bring a much larger area of this fruit under cultivation in California, but also inevitably in other states. The Hachiya, which has commanded a premium over other varieties, does not thrive as well in the southern states as some others now less favored in the markets. In this respect California has some slight advantage. If the industry
is to continue to prove a profitable one, the same economic laws which have made possible the development of other fruit industries in California must be observed—the production of only the uniformly highest quality fruit at the lowest cost.

The persimmon has a decided advantage in maturing at the time of the winter holiday season and much can be done to increase its popularity. No concerted efforts have been made to advertise the fruit and its many uses. This can be brought about only by cooperation among the growers. Already a step has been made in this direction in the formation of the Persimmon Growers Department of the Southern Counties Farm Bureaus in the fall of 1922, and the more recent organization of the persimmon growers of northern California, for the expressed purpose of studying mutually all problems of production and distribution. The indications are that the persimmon growers will follow the successful example afforded by other California fruit industries. There is, therefore, good reason to believe that persimmon culture will eventually assume a permanent and important place among the many successful subtropical fruit industries for which this state is justly famous.

ACKNOWLEDGMENTS

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