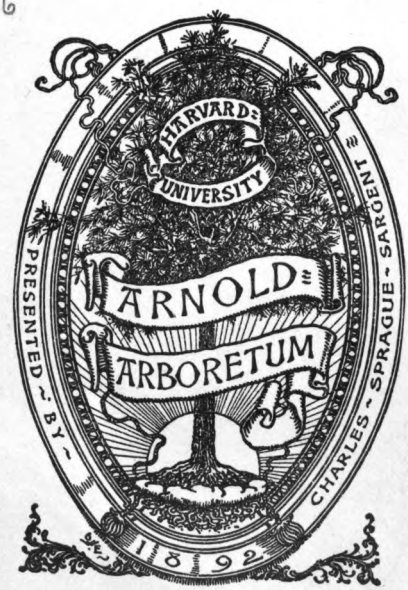
R.W. HODGSON



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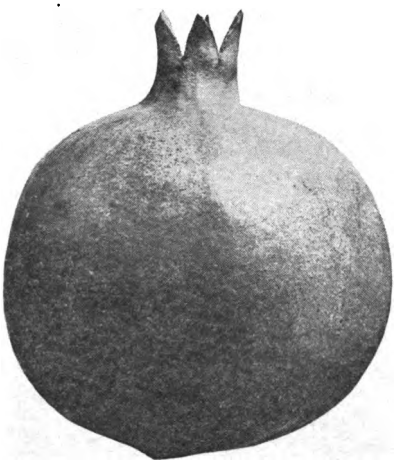
THE POMEGRANATE

BY
ROBERT W. HODGSON



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THE POMEGRANATE

By ROBERT W. HODGSON

FOREWORD

This bulletin was first submitted as a thesis for the Bachelor's degree in the College of Agriculture. The thesis was prepared under the supervision of the undersigned, who considered part of the monograph of sufficient general interest to warrant publication. The thesis has therefore been rearranged and edited, the larger part of the historical study being omitted. On the other hand the subjects of more vital interest to growers, such as pruning and orchard management have been somewhat expanded after additional observations and investigations were made in the orchards during the past summer.

We wish to acknowledge the kindly assistance of many growers who have so cheerfully given specimens and information and lent their aid in various ways.

J. Eliot Coit.

INTRODUCTION

According to the census reports for 1910 pomegranates were grown in quantities large enough to receive special attention from the census officials in the following states: California, Arizona, Georgia, Alabama, Nevada, and Utah. In the remaining southern states they are grown to some extent but not commercially. The total production in 1910 is given at 145,840 pounds, valued at $3,909.

At the present time, California has about 125 to 150 acres planted in pomegranates as follows: Porterville district, 60 to 65 acres; Fresno district, 25 to 30 acres; Imperial Valley, 15 to 25 acres; and the rest of the state, 25 to 30 acres. In 1915 one firm in the Porterville district handled 7219 boxes, which netted the growers $6,136.15, or twice as much as was received for the crop of the whole United States in 1910. Evidently the industry is growing.

The pomegranate thrives in all the interior valleys of California and in Arizona, producing heavy crops of excellent fruit. There is no good reason why this fruit may not be produced cheaply and in any quantity the market demand may justify. The only hindrance to a rapid extension of pomegranate planting in California is the lack of market demand. This is easily accounted for by the ignorance on

the part of the American public of the good qualities of the fruit. Spanish-speaking peoples fully appreciate the pomegranate and consume the fruit in considerable quantities, while the consumers in the neighborhood of the large fruit markets of the United States, being accustomed to the apple, peach, grape, and orange, hesitate before a strange fruit, to the good points of which they have not been educated.

The extension of the pomegranate industry is therefore largely dependent on the education of the public. The people of the United States are notably large consumers of fruit and the present widespread interest in new fruits indicates a demand for greater diversification. That pomegranates are included in this new demand is shown by the increased sales and fair prices mentioned above. The

Fig. 1.—Commercial pomegranate orchard near Porterville.

introduction of a new fruit into the markets is necessarily a slow process, but the pomegranate is such a worthy fruit that it will be sure to win a greatly increased consumption, especially if assisted by a little judicious advertising.

HISTORY

The pomegranate has been grown from most ancient times. All the botanical, historical, and philological data so far examined agree in showing that our modern species, *Punica granatum,* is a native of Persia and adjacent countries where it was highly esteemed before the advent of the almond, apricot, or peach.

Like the fig, vine, and olive, it claims a place in the earliest annals of history and was classed in point of utility with the grain-bearing plants and honey, these constituting an important part of the food of the nations of antiquity in their early stages of civilization.

Inasmuch as the pomegranate was mentioned many times in early Grecian history before the founding of Rome, it is evident that the Greeks were familiar with this fruit a considerable time before it was introduced into Rome by way of Carthage. Homer mentions the pomegranate twice in the Odyssey as a fruit common to the gardens of Phoenicia and Phrygia. Herodotus, the Greek historian, states that when the Persians under Xerxes invaded Greece there was a regiment or battalion known as the "Pomegranate Brigade." These soldiers constituted Xerxes' own bodyguard, and carried spears with golden pomegranates at the lower end instead of spikes. The battle of Marathon occurred about 490 B.C., hence we can see how early the pomegranate was recorded in Grecian history. Theophrastus described it carefully in his Natural History written about 350 years before the Christian area. Pomegranates are mentioned several times in the Old Testament, but only as cultivated plants. The Israelites had become familiar with the tree and fruit in Egypt, for in the long wandering through the Wilderness they murmured for "the fruits of Egypt, the fig, the vine, and the pomegranate." Pomegranates were evidently held in high esteem, for King Solomon sings of "an orchard of pomegranates with pleasant fruits."

Frequent mention is made of the pomegranate by Roman writers. Pliny considered it a most valuable fruit and declared that the best kinds came from Carthage. Galen and Dioscorides, Roman physicians, mention its medicinal qualities. Palladius and Columella call attention to the fruit several times in their writings. In Spain it flourished and came to be regarded as the symbol of the Golden Age in Granada. To-day the wide-spread thickets of pomegranates in Spain furnish almost the only signs of the Moorish occupation. Ibu-al-Awam, a Moor-Spaniard of the twelfth century, described eleven varieties of pomegranates growing at that time. Granada, in Spain, owes its name to the far-spread fame of its pomegranates, the fruit reaching a high degree of perfection in its gentle climate.

During the middle ages the fruit came to be known as *Pomum granatum,* or seeded apple. By contraction this has resulted in our present common name pomegranate. Linnaeus gave it the scientific name *Punica granatum.*

After Cortez conquered Mexico in 1521, the Jesuit padres soon began their missionary work among the Indians. With them they brought the fruits of France and Spain, and among these the pomegranate.

All the fruits from the older missions in Mexico were carried northward and planted in the new mission gardens in California. In these

gardens may still be seen some of the old olive and date trees and pomegranate bushes. In 1792 Vancouver found an orchard at Mission San Buena Ventura in which pomegranates were growing together with apples, pears, plums, figs, oranges, grapes and peaches. Robinson mentions an orchard of pomegranates at the Mission San Gabriel.

The type of pomegranate grown at these missions is of a mongrel seedling origin, but is of fair quality and well liked by many people. It has a rather wide distribution. Since 1850 many new varieties have been introduced, some by way of the southern states, principally Florida and Georgia, but mainly from the Mediterranean countries and China. Until recently most of the plantings in California have been seedlings or cuttings taken indiscriminately. The number of different forms now growing in the state is therefore large and varied and furnishes excellent material for the selection of better commercial varieties. Several superior varieties have appeared and are now being propagated. The most promising of these is the Wonderful, which is the only pomegranate now being grown commercially in California.

Although the exact date of the introduction of the pomegranate into the eastern United States is not known, it is probable that it was taken, along with the orange and other fruits, to Florida at an early date. However, it was not until the middle of the nineteenth century that attention was directed to the culture of this fruit in the south. At that time varieties from California and southern Europe were introduced and a few plantings made, chiefly as garden and door-yard trees. However, pomegranate growing has never become a commercial industry although the shrub is now quite common throughout the southern states. Some very good varieties are found, but little attempt has been made at developing a market for the fruit, and it is principally grown for home use. Pomegranate plants will grow as far north as Washington, D. C., but they will seldom mature fruit farther north than eastern North Carolina, and at that latitude fruiting is quite uncertain.

BOTANY

There is much disagreement among systematic botanists as to the proper classification of the pomegranate, but all agree that it is a member of the Order *Myrtifloreae* or *Myrtales*. The number of groups or families in this order varies from nine to twenty, according to the systematist classifying them. Some place the pomegranate in the Myrtle group and some place it directly in the Pomegranate family, but all agree that the family is distinct and contains only one genus. The

following paragraphs contain a description of the more important botanical characters of this genus.

Punica granatum, L. The Pomegranate.

A large shrub or small tree; bushy in growth; usually deciduous, though there are varieties which are practically evergreen. Leaves without glands and marginal veins; mostly opposite; lanceolate, long, or obovate; obtuse; entire; glabrous; young growth red-veined; bright glossy green; average one-half inch wide by three inches long.

Branches slender; twiggy; nearly cylindrical; somewhat thorny; new growth four-angled. A peculiarity of the thorns is that they are modified stem structures and not of leaf origin. The small twigs often terminate in these thorns, as do usually also the short side shoots. These vary somewhat in length but

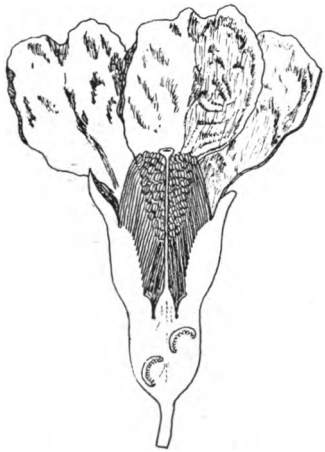

Fig. 2.—Cross section of pomegranate flower showing position of carpels.

average one-fourth to three-fourths of an inch. Varieties vary a great deal in thorniness.

Flowers axillary; solitary, or in small clusters; borne mainly at the tips of the branches in a zone on the outer edge of the tree. Produced on short spurs grown on two or three-year-old wood; average inch to inch and a half in length. Calyx stiff; tubular; showy; orange or red in color; five to seven lobes or sepals; crowned with crumpled petals; bright scarlet or white in color; lanceolate to obovate in shape; equal in number to the sepals and inserted between them. Stamens numerous; inserted on inner wall of calyx-tube. Ovary inferior; spherical; imbedded in fleshy calyx-tube or receptacle; surmounted by single long, slender style. Stigma small; discoid. Ovary contains seven to fifteen carpels or locules, arranged in two whorls or series, one interior and lower, containing three carpels; the other exterior and upper, containing six to twelve carpels. Ovary ripens into a large, baccate, many-celled, many-seeded, pome-like berry, crowned with a showy, persistent calyx. The rind or pericarp, formed by the wall of the calyx-tube, is tough and hard.

The morphological development of the fruit is peculiar (Fig. 2). During the growth the carpels of the upper series are turned around as though they had been rotated 180 degrees in a plane parallel to the long diameter of the fruit. In the mature fruit, therefore, we find the carpels of the lower tier occupying their original positions, attached to the base of the fruit. In the upper series, however, though irregular in size and shape, they are attached to the periphery of the fruit.

Each locule contains a variable number of small, angular, berry-like fruit-bodies, the angularity being due to their lying closely packed together (Fig. 13). Each of these is covered with a thin membrane which encloses a fruity mass very rich in juice. The fruity mass or aril comprises the edible portion of the fruit. It arises by the ex-

Fig. 3.—Large flower with perfect ovary compared with abortive flower showing merely the rudiment of an ovary.

ternal portion of the seed-coat becoming succulent. The arils are transparent, with a beautiful clear color ranging from pale pink to dark crimson, and contain a seed of variable size, enclosed in a shell or seed-coat of varying degrees of hardness. Within the seed-coat the cotyledons are rolled together in a spiral fashion.

The pomegranate rind is tough and leathery and varies in color from pale yellow to deep purple red. The rind itself is always fairly thin and must be distinguished from the pulp or rag. In some varieties the amount of rag is large and the rind is lined with a layer which gives it the appearance of being thick. In others this is not the case, and the arils extend to the rind itself. Thus it is possible for a pomegranate to have a thin rind but a large percent of rag or pulp, and vice versa. The pulp, rind, and thin separating parchments or membranes are all bitter and astringent, containing appreciable quantities of tannin. The fruits vary from three to six inches in diameter.

A varying percentage of pomegranate flowers is sterile and does not set fruit, falling early. These flowers, which are not as long as the perfect flowers, have the pistil reduced in varying degrees, in some only a rudiment being present. All stages in its development may be found from almost none to the large pistil with long style in the perfect flower. Ornamental types are almost entirely sterile.

Pomegranate trees and bushes are very graceful in form and foliage, having a marked drooping, willowy effect when trained to

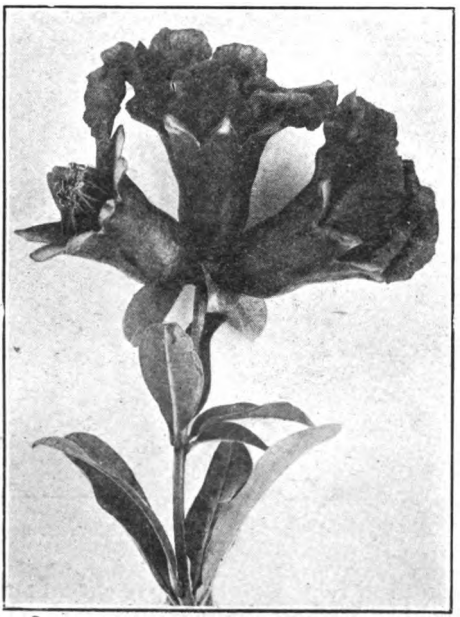

Fig. 4.—Showy calyx-tube and petals of the pomegranate flower.

tree or arbor form, and a round, compact, bushy shape in their natural condition. They are well adapted for use in hedges, having a strong tendency to a knotty, irregular growth, and suckering freely from the roots and crown. This suckering habit is so pronounced that in training to tree form, suckers must be removed very frequently. By careful pruning the pomegranate may be trained into a small tree reaching a height of fifteen to twenty feet.

The pomegranate is valued as an ornamental tree on account of its bright glossy green leaves and the profusion of its large blossoms. These are produced over a long period of time, from April to September, and on the outer portion of the tree so that the flaming red of

both the petals and calyx-tube forms a rich contrast to the dark green foliage. The fruit begins to ripen in September and if not picked hangs on the tree until January. Thus for nine months of the year, April to January, the tree is ornamental. Pomegranates are rather slow to leaf out in the spring, putting out leaves at about the same time as the fig.

The plant is very long-lived as compared to many of our fruit trees. Plants are still living in the mission gardens, which were planted by the early padres. At Paris and Versailles in France are specimens which are known to have fruited for over two centuries.

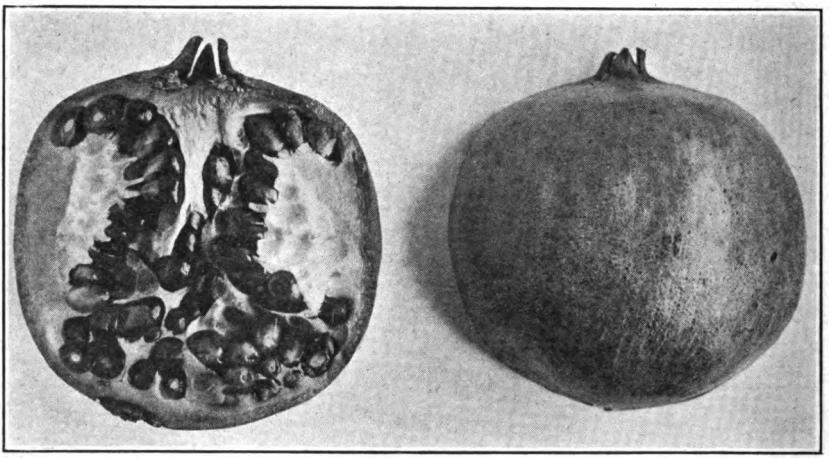

Fig. 5.—Type of good commercial pomegranate.

Some of the botanical relatives of the pomegranate are the delicious guava, the feijoa, the rose apple, cloves, the fuchsia, and loosestrife.

HORTICULTURAL VARIETIES

There are two general types of pomegranates growing in California at the present time.

White-flowered Type.—This sort of pomegranate has been introduced within the last twenty or thirty years. Some varieties belonging to this type are deciduous, some are more or less evergreen. The fruit is round-oblate or obovate in form, of a pale lemon or fawn color, and the rind is invariably thick and soft. The edible portion is small to medium in amount; the arils are large and translucent; and the seeds are large to very large, with thick bony seed-coats rendering them difficult to chew and inedible. The flavor is flat, insipid, and lacking

in the acid element. The appearance is very poor and the fruit has poor keeping quality. It is very easily bruised and these injuries become conspicuous in storage as ugly brown blotches which detract from the appearance. This type is undesirable and is not being propagated to any extent.

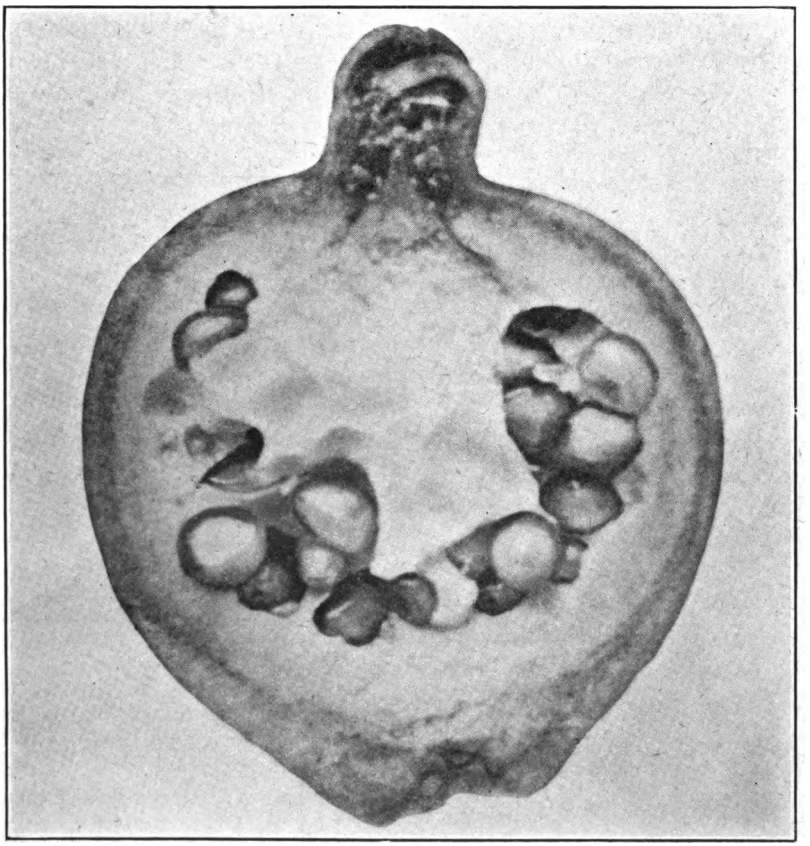

Fig. 6.—Type of fruit worthless for commercial purposes.

Pink or Red-flowered Type.—This type includes most of our common pomegranates and all of the desirable and commercial varieties. So far as we know, the tree is always deciduous. The fruit is round oblate or obovate in form, according to variety; the rind varies from thick to very thin; the edible portion is small to large in amount; the arils vary much in size, and are pale pink to bright crimson in color; and the seeds also vary in size and range in hardness from the so-called

"seedless" varieties, in which the seeds are edible, to very hard and bony seeds. The fruits vary in color from a pale lemon yellow washed with light pink to a bright crimson with a deep purple tinge.

Requirements of a Good Commercial Pomegranate.—Fruit medium to large in size; pink or bright red with a glossy surface; relatively free from splitting at maturity; length of calyx-tube medium or short, with the lobes reflexed or inflexed, not upright. Rind thin, tough, and well adapted to shipping. Flesh abundant, bright red or crimson. A small amount of rag or pulp. Seeds small in proportion to the aril; tender and easily eaten; juice abundant and well-colored; flavor rich, sprightly, vinous and subacid.

The complete list of varieties is long, but only five are found on the market. Of these, the Wonderful is by far the best. This variety occupies the same relation among pomegranates that the Washington Navel does among winter oranges in California. On account of its vigorous growth and habit of regularly bearing large crops of high quality fruit, it is a universal favorite. At the present time fully 75 per cent of the pomegranates shipped to the markets, and nearly all of the newer plantings, are of the Wonderful variety.

Wonderful.—About 1896 a Mr. Bearss of Porterville obtained a quantity of pomegranate cuttings from Florida. One of these bore fruit unlike the others, and proved especially good. He propagated this and called it the Wonderful.

Fruit large and attractive; deep purple-red, glossy; flesh deep crimson; juice abundant and deep crimson; flavor excellent, vinous, rich and sprightly; seeds fairly tender; rind medium in thickness; calyx medium in length. A very good shipper and commands a premium on the market. (See Fig. 12.)

Paper Shell.—Large, attractive; pale yellow washed with pink, glossy; flesh bright red; juice abundant and bright red; flavor good; seeds fairly tender; rind very thin; calyx small. Received its name on account of its thin rind. An excellent fruit for home use. Tree not so vigorous as Wonderful or Spanish Ruby. This variety was introduced from the southern states and is probably the second in importance in California.

Spanish Ruby.—Large, attractive; bright red, glossy; flesh crimson; juice abundant, bright red; flavor sweet and aromatic; seeds fairly tender; rind medium in thickness; calyx medium. This is another variety imported from the South, where it is often called the Purple Seeded or Purple variety. It stands third in importance in California.

Sweet Fruited.—Medium in size; pale yellow, lightly striped with pink; flesh pale pink; juice moderate in amount; flavor pleasant and aromatic; seeds fairly tender; rind medium; calyx medium.

Subacid.—Medium in size; pale yellow with pink flush; flesh clear red; juice moderate in amount; flavor quite tart and sour; seeds not edible, but readily chewed; rind thin, calyx large. Very much like the Sweet, but more acid.

Other varieties frequently found are the *Radinar, Dessia, and Sin Pepitas.* This last is a so-called "seedless" variety, but in the United States at least, has been found to have seeds, although they are quite tender and easily eaten.

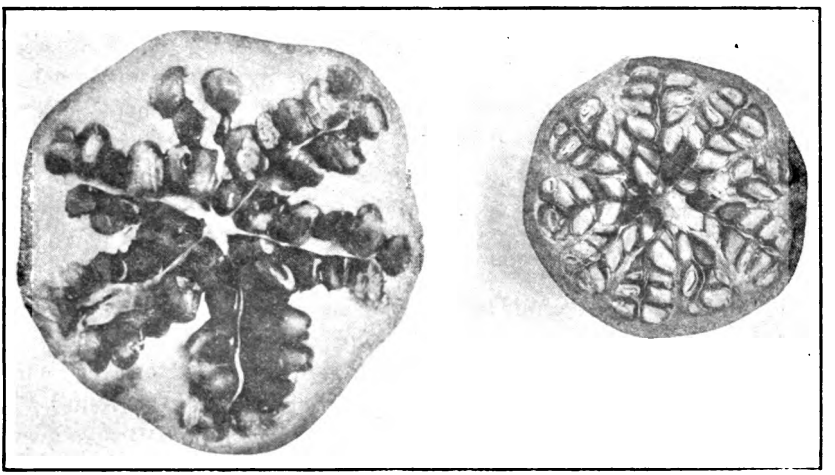

Fig. 7.—The small fruit has a thick rind but little rag, small arils and large seeds. The large fruit has thin rind and much rag, large arils and small seeds. Neither is satisfactory.

Varieties occasionally found are the *Jative, Hermosillo, Acid,* and others.

The Division of Seed and Plant Introduction of the U. S. Department of Agriculture has made 135 to 140 introductions of pomegranates from many foreign countries. These come from many localities throughout southern Europe, northern Africa, Asia except Siberia and Japan, and Argentina. A number of these plants are now fruiting in U. S. Government gardens at Chico, Butte County, and at Indio, Riverside County. Among them are several of considerable promise.

Ornamental varieties grown are the *Double-flowered* and *Dwarf* pomegranates. These may have red, yellow, white, or variegated blossoms and are valuable additions to the list of landscape planting materials available for the hottest interior valleys.

CLIMATIC REQUIREMENTS

Altitude.—Aaronsohn reports the pomegranate growing and thriving in Palestine at elevations of 1000 to 1300 feet, some varieties doing better at sea level or near the coast and others at higher elevations. On the interior high plateau of Spain, pomegranate growing has reached a high stage of perfection, the fruit being noted for its superior quality. The bush is found wild on the hillsides in the Russian Caucasus at elevations of 2000 to 3000 feet. Pomegranates flourish on the Deccan plateau of India at elevations of 3000 to 4000 feet. In South America the tree is reported growing in Peru at high elevations, while in Mexico it flourishes on the interior plateaus. Fruit of very fine quality is grown in Arizona, New Mexico, and Texas, as well as in the Great Basin region at elevations ranging from below sea level to 4000 feet. In California the experiment station reports the fruit as doing exceptionally well in the Sierra foothills. Here the pomegranate grows and fruits at elevations where considerable snow falls in the winter.

Thus we may conclude, from all the information available regarding elevation, that the pomegranate flourishes and fruits in perfection in a wide range of altitudes ranging from below sea level to 4000 feet.

Rainfall.—The pomegranate is essentially a desert plant, being well adapted to withstanding long periods of drought. However, under such conditions, little fruit is borne. Specimens may be found, still alive and holding their own, on old abandoned homesteads in the deserts of southern California and Arizona, which on application of water will quickly recover and fruit again. On account of this great resistance to drought, it would seem that more general planting of the better varieties would be justified in those regions where water is scarce, or the regular supply subject to interruptions.

On the other hand, the pomegranate will grow and fruit under conditions of heavy rainfall. This is the case in Florida and in the other southern states, as well as in Hawaii, India, and the Philippines. However, fruit produced in these regions is of poor keeping and shipping qualities, being soft and succulent, as well as only fair in eating quality.

The most satisfactory rainfall conditions for the production of pomegranates are those found in the Sacramento, San Joaquin, Imperial, and Coachella valleys in California, and in the irrigated valleys of southern Arizona and Sonora, Mexico. In California the year is divided into two seasons, wet and dry, the dry coinciding with the

growing season of the pomegranate. The rainy season is late and short, beginning in November and usually ending about the first of March. From March until November the weather is usually clear and sunny and from May to October very hot and dry. The pomegranate requires a long growing season, since it blooms in May, but the fruit does not ripen ordinarily until October or November. In the dry, hot climate of the Imperial and Coachella valleys the fruit is edible as early as the middle of June, and ripens in August and September. For best results this season should be dry, for under these conditions fruits of excellent eating quality as well as remarkable keeping quality, is produced. Such conditions are found in the southwestern United States and northwestern Mexico, as well as in Palestine and Spain.

Temperatures.—One of the limiting factors in pomegranate growing is temperature. Although more hardy than citrus, the tree is not in the same class as the stone fruits and cannot endure temperatures lower than 8 to 15 degrees F. without serious damage, and is frozen to the ground by zero temperatures. As it blooms late in the spring there is little danger from frost. Reasoner states that the freeze of 1886 in the South killed all the sweet pomegranates to the ground, but did little damage to sour varieties. This greater frost resistance of the sour varieties has been noted several times. Zakuro reports the pomegranate as hardy as the fig in Japan. Blair and Hastings state that the pomegranates at the experimental farm near San Antonio, Texas, are occasionally frost-injured.

On the other hand, we know no climate that is too hot for the pomegranate. At Aden, Arabia, where the summer temperatures are so high that Europeans are said to rarely venture out except at night, the pomegranate thrives wherever it has water. It may be classed, in point of temperature requirements, with the fig and the olive, although because of its different blooming period it regularly fruits in regions of somewhat lower average temperature than either.

For the proper maturing of the fruit, the sum of daily mean temperatures during the growing period must be high. The best fruit, both in size, color, and quality, is produced in those districts where the summation of heat units received is very high. Pomegranates from desert regions are noted for their fine flavor and color. In the Old World they are often interplanted with figs and other semi-tropical fruits between the date palms. On the other hand, fruit of fair quality can be produced in regions where dates cannot be grown commercially, due to the humidity of the atmosphere.

Pomegranates seldom ripen well in California near the Pacific coast or in cool regions, usually remaining very sour and tart, as well as poorly colored. Moreover, the ratio of acid to total solids runs high, and when exposed to cool sea breezes, the plant does not bloom well or set much fruit.

We may conclude then, that using the proper varieties, pomegranate culture is limited to those districts with altitudes up to 4000 feet, with long, hot, dry summers, and situated in a belt about the earth, extending in width from the forty-first parallel south latitude to the forty-first parallel north latitude.

PROPAGATION

The pomegranate is very easy of propagation, which may be accomplished by seedage, cuttage, and layerage.

Hardwood Cuttings.—The only method of propagation used commercially is by hardwood cuttings. These will grow in the open ground about as readily as willow cuttings. The stand obtained is very satisfactory and the method used very simple. In February or March hardwood cuttings, ten to twelve inches long and one-quarter to a half inch in diameter are cut, usually from the shoots or suckers, and are planted in the open ground in nursery rows. These rows are ordinarily three feet apart and the cuttings spaced eight to ten inches in the row. The cuttings should be thrust almost their entire length into the earth, leaving only the top eye exposed. This eye is forced out and grows into the tree. Cuttings of this sort grow thriftily and are often ready for transplanting to the orchard or hedge by the following spring, although they are frequently left in the nursery row two seasons. Hardwood cuttings are sometimes cut in the fall and callused in sand over winter, then set out in early spring. This may result in a little earlier growth and consequently a larger tree that season, but is not necessary to insure striking root.

Softwood Cuttings.—Propagation is sometimes accomplished later in the season by the use of softwood cuttings. These will grow if given careful attention. Best results are obtained by rooting them in cutting-beds or green-houses. They strike roots in several weeks and if properly cared for, may be set out the following spring. As this practice possesses no special advantages it is little used.

Layerage.—The pomegranate layers about as readily as the grape. This method is little used, however, as propagation by cuttings is so easy.

Seedage.—Pomegranate seeds germinate readily without undergoing any resting period. As the fruit keeps in storage until February or March without any difficulty, seeds may be taken directly from the fruit and planted. These are usually placed in flats and kept in a cold-frame or hot-house until the seedlings are well established. A

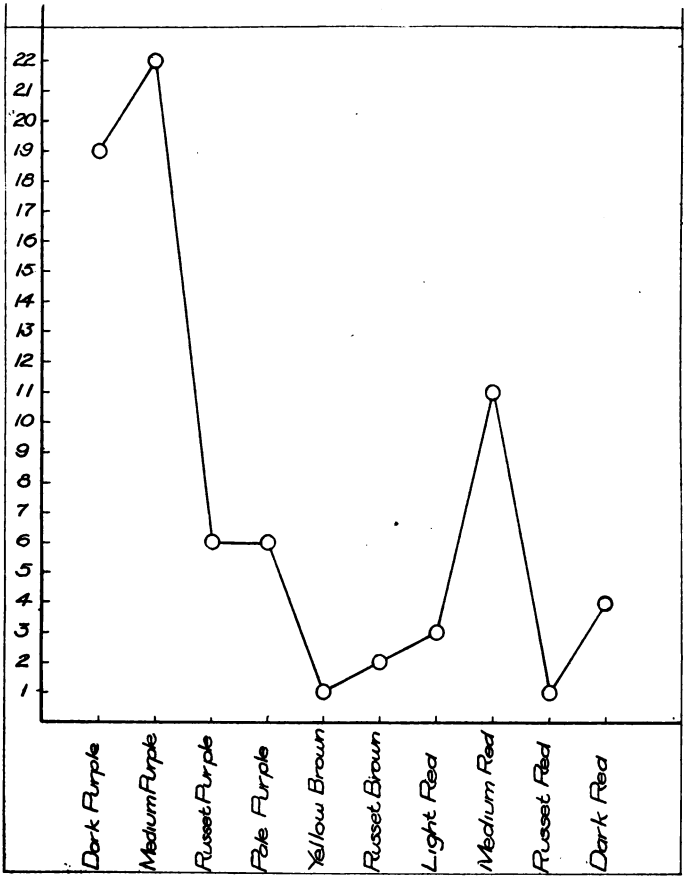

Fig. 8.—Color variation in fruits from the progeny of one Wonderful pomegranate. Abscissa, type color of fruit. Ordinate, number of seedling plants.

fair stand is usually obtained. This method of propagation should not be used commercially as the seeds do not come true to variety, the range of variation in fruit obtained from the seed of a single pomegranate being very wide.

A study of seedling pomegranates made by J. E. Coit in 1914–1915 showed that the normal range of variation to be expected is very great.

In 1909 the seeds from two pomegranates of widely differing type and variety were planted in separate rows at the experiment station at Meloland in the Imperial Valley. One fruit was from Porto Rico, pale yellow in color, with a scanty supply of insipid juice, and hard, bony seeds which were absolutely inedible. The other was of the

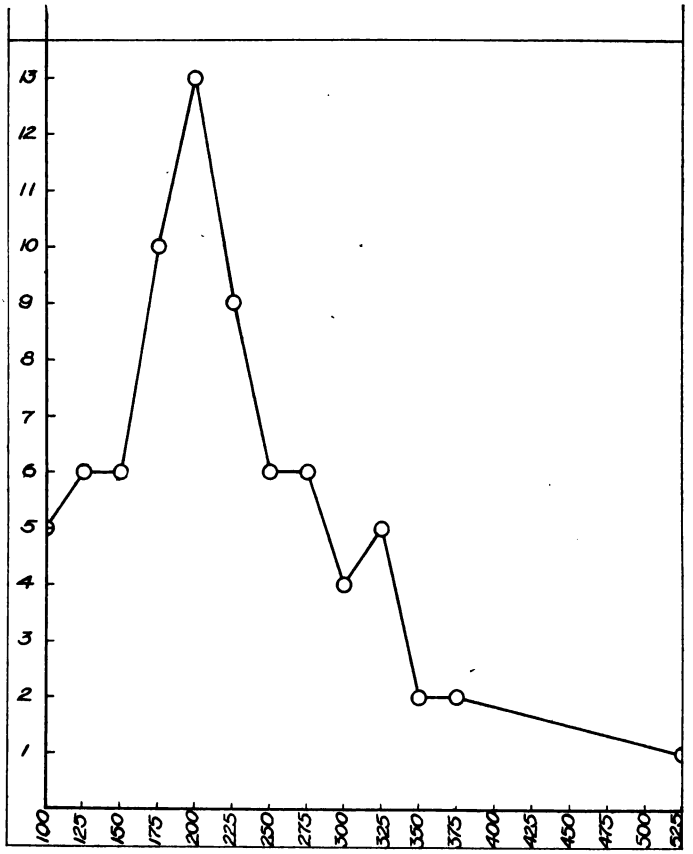

Fig. 9.—Size variation in fruits from progeny of one Wonderful pomegranate. Abscissa, average weight in grams. Ordinate, number of seedling plants.

Wonderful variety. In 1914–1915 these trees were in full bearing and at this time two fair sample fruits from each tree were selected for study. These were carefully weighed, measured, and described separately. In both varieties a wide degree of variation in all characters was noted. Every degree of variation in fruit and flesh color in a series from pale yellow to deep crimson was obtained; much variation

in the length of calyx-tube and sepals was found; a great variation in size and weight, thickness of rind, hardness of seed, and amounts of pulp and flesh were observed. The results obtained in this study are shown in figs. 8 and 9 and emphasize the fact that propagation should always be by cuttings from plants of known desirable type.

SOILS

While the pomegranate is not at all exacting in its soil requirements, the weight of evidence tends to show that yields are heaviest and quality best on deep soils of a fairly heavy nature. Pomegranates have been planted in California on many soil types, ranging from almost pure sand to heavy clay, and have grown and fruited with a greater or less degree of success. Experience has shown that, while the tree grows on light soils, yields are much lighter and the color much poorer than on the heavier types. While the pomegranate is quite resistant to alkali it cannot be expected to produce the best quality fruit on soils strongly impregnated with alkali. The same might be said regarding moisture conditions. The soil should be fairly well drained, although the tree will thrive and fruit on soils rather heavier and wetter than those used for pears. In fact, the pomegranate is remarkable for the amount of water in the soil it will endure.

ORCHARD MANAGEMENT

Planting Systems.—At the present time pomegranates are most commonly grown in hedge form or as border trees, although some plantings, especially the more recent ones, have been made in orchard form. When planted as hedges or border rows the bushes may be spaced as close as six to eight feet, growing together with limbs interlocked so that a compact hedge is formed. The pomegranate is especially well adapted to this style of planting, as it suckers readily and soon forms a dense, impenetrable wall.

Planting distances when the trees are set in orchard form have not been standardized as yet and vary considerably. The consensus of opinion of growers in various parts of the state regarding the correct distances for pomegranates is that they should be spaced fourteen to eighteen feet on the square system.

Interplanting.—Pomegranates are used to some extent as interplants. At the present time some are being interplanted with olives at eighteen feet, the hexagonal system being used. Some orange

groves are interset with pomegranates. When this is done the usual form of planting is the triangle system, with the pomegranates set twelve by twenty-four feet apart.

Planting Season.—Pomegranate trees should be planted as early in the spring as the ground can be readily worked and is not too wet. However, as the pomegranate starts growth comparatively late in the spring, late planting is not accompanied by such disastrous effects as is the case with the stone fruits. The best results seem to be obtained by planting in February and March, as the tree then has a chance

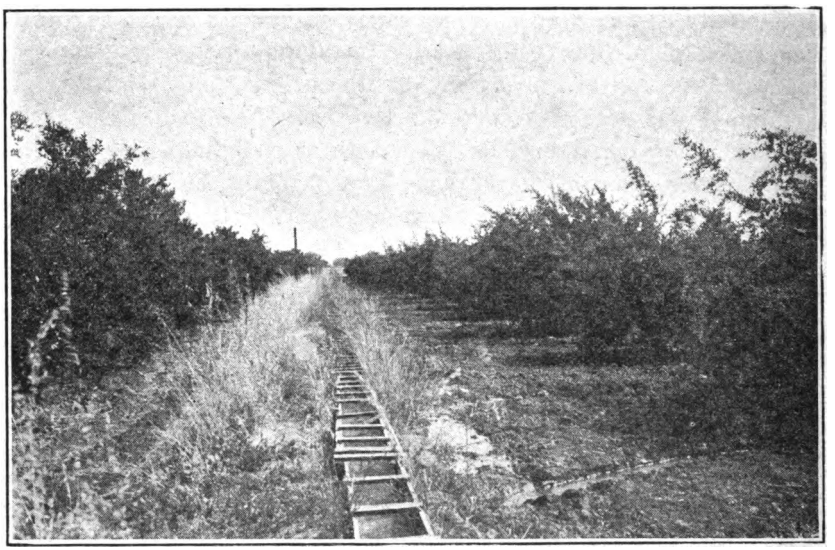

Fig. 10.—Irrigating flume serving pomegranates on the right. Orange orchard on the left.

to get well established in place and to grow some feeding roots before leafing out.

Preparation of the Land.—Previous to planting, the land should have been well plowed and cultivated. If the soil is in good condition, little care other than irrigation and two or three cultivations during the season is needed after planting. In older orchards the soil should be stirred at least once a month during the growing season. The object is to maintain a good soil mulch to conserve the soil moisture. Cultivation practice varies greatly among growers, and while some report good crops obtained with little or no cultivation, the best results seem to be obtained by a judicious use of the cultivator and spring-tooth harrow.

Irrigation.—Although the pomegranate will endure extended periods of drought, it requires about as much water as peaches or apricots to fruit abundantly. Commercial practice varies considerably in the amount of water applied. Some growers irrigate but little, while others apply as much as they give their citrus orchards. The information available, however, seems to indicate that for best results a moderate amount of water should be given the trees. If we set the water requirements of orange trees at fifty inches, including the rainfall, we may consider that the pomegranate requires thirty-five to forty inches. Some of this water comes as rain in the winter season. The rest is usually applied in two to five irrigations, distributed through the growing season. Some growers irrigate until July only. Others apply water once a month until September. The furrow system is used almost universally.

Pruning.—Pruning of the pomegranate is a subject on which there exists a wide diversity of opinion among growers and a corresponding diversity in pruning practice. Some prune severely, others moderately, but the usual practice is to do nothing except to cut out interfering branches and dead wood.

Depending on the form desired and the method of planting, the pomegranate needs different treatment. Pomegranates are grown in hedge form, border rows, and orchard form and each requires a different sort of training. When grown as a hedge it is customary to let the plants grow as they will without any pruning whatever. When grown in orchards some prefer the bush form, some the tree form with a single trunk. On account of the large amount of suckering to be done the first few years, it is difficult to train the pomegranate into the tree form, but it can be done especially if the trunk is kept firmly tied to a strong stake during the first few years. If headed too high, plants of the tree form are likely to be blown over by strong winds. Correspondence with many of the pomegranate growers in the state indicated that they were more inclined to the bush than the tree form.

To prune intelligently, one must consider the fruiting habit, and habit of growth of the tree. The pomegranate is a vigorous grower, sending up each year a number of shoots from the root which gives the plant a bush form unless otherwise trained. The fruit is borne terminally on short spurs produced on slow-growing mature wood. This wood bears for several years but as the tree increases in size this wood loses its fruiting habit, which is assumed by the younger growth. Little or no fruit is produced in the interior of the tree. Thus we have the fruit produced in an outer zone or shell which gradually grows farther away from the body of the tree.

Bearing this in mind, it can be clearly seen that a heavy pruning, especially shortening in of the older wood, will greatly reduce the crop for the next two or three years. A correlation between small crop and heavy pruning has been noted in several commercial orchards. In every instance where the grower has pruned heavily, the crop is comparatively light and where growers have practiced moderate pruning or none at all, the tree is reported as a heavy bearer.

It should be borne in mind that the market demands a large pomegranate and will pay well for it. "Jumbo" fruits bring a premium, while small fruit sells at a heavy discount. Therefore the aim should be size and quality, rather than quantity. A large pomegranate weighs two or three pounds, and it is not unusual for an old tree to bear 400 to 500 pounds of fruit. To stand up under such a load the tree must have a strong framework.

From all the information available at the present time we may outline a system of pruning for the tree form about as follows: When the tree is planted it should be cut back to a whip at about twenty-four to thirty inches from the ground. As the buds put out and shoots are produced, these should be selected and thinned out to three or five or more scaffold branches which should be pinched back to make them stocky. These should be spaced some distance apart, the lowest at least eight or ten inches from the ground, and symmetrically arranged on the stem. The following winter the scaffold branches should be shortened in about three-fifths of their length. In the spring the new shoots arising from the scaffold branches, primary branches, should be restricted to two or three per limb. The main stem and frame limbs should be kept free from suckers at all times. The aim in pruning while the tree is young is to train the plant to the tree form and to induce the formation of a stocky, compact framework. This should be accomplished by the end of the second or third year.

After the framework has been established all the growth is left and the tree comes into bearing. From this time to the age of fifteen or twenty years, the tree increases slowly in size and yield. Pruning after the third year should be confined to a regular removal of all sucker growth arising from the root, and interfering branches as well as dead brush, and an annual thinning out or removal of some of the older branches. This should be done after the leaves fall in winter. If this system is followed, a strong, upright tree, bearing 200 to 400 pounds of large, well formed and colored fruit can be obtained, provided other conditions are favorable. In training to the bush form the same general procedure is followed except that at the beginning from three to five main stems are selected instead of one.

Harvesting, Packing, and Marketing.—On account of the common habit of splitting the fruit of most varieties of pomegranates must be picked before fully mature. In some varieties the fruit bursts wide open on maturity and the arils dehisce after the fashion of peas from a pod. In others it cracks just enough to expose the arils and spoil the fruit. There is much variation regarding this tendency. Some trees will hold their fruit until winter and never show any splits.

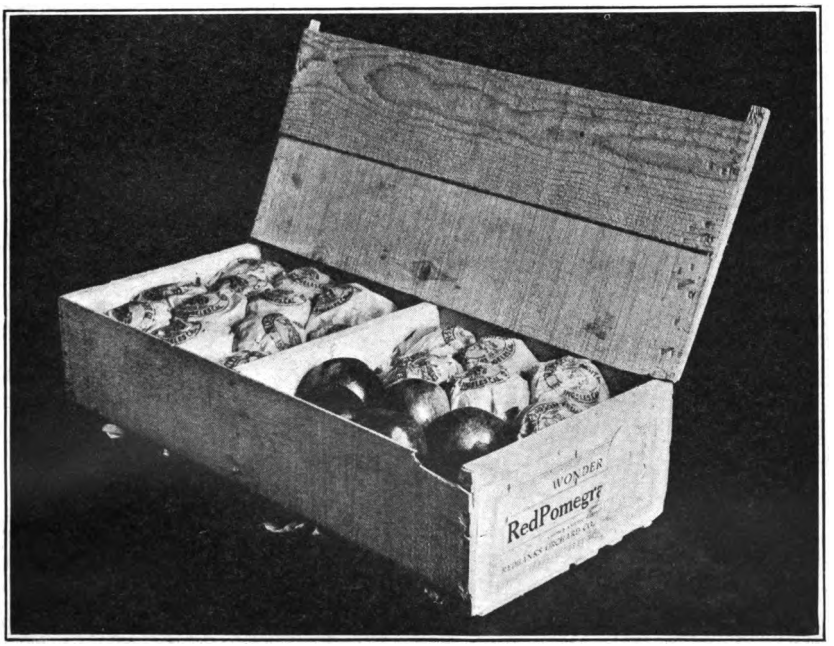

Fig. 11.—California pomegranates; standard commercial pack.

Others may have a high proportion of bad splits. To avoid this difficulty most of the fruit is picked before fully ripe.

Fortunately the pomegranate is one of those fruits which, after reaching a certain degree of maturity, continues to ripen in cold storage, where it will keep in excellent condition for five or six months. Not only does it ripen, but the quality is improved, the flavor becoming richer and more vinous. The rind shrinks and becomes thinner and tougher; the amount of rag decreases; the seed coats appear to become more tender and edible. Several pickings should be made, the first about the first week in October and two or three others at weekly intervals.

Pomegranates are very securely attached to the fruiting wood by thick, strong stems, and should be clipped rather than pulled. If pulled from the tree, damage may be done in breaking the limbs, but it is almost certain that the stem will pull loose from the fruit, taking with it a part of the rind about the base. Care should be taken in handling the fruit to avoid bruising, as it is quite susceptible to injury.

The fruit is gathered in picking bags and emptied into field boxes. These are hauled to the packing-house, usually belonging to the local citrus association, where the fruit is packed. Here it is brushed or wiped if it is particularly dirty, although this process is usually omitted. The fruit will take a high polish, making it very attractive, and wiping would seem well worth while. It is next sized, the sizes running from 24 to 110 per box. After sizing, the fruit is wrapped in tissue paper and packed.

The commercial package used is the orange half-box, made of six pieces, two each for the top and bottom, and one for each side. When packed, these boxes average thirty-five to forty pounds in weight. Care taken in packing the fruit is well repaid, for pomegranates are sold partly for their ornamental value, the price varying widely according to the size of the fruit and the neatness of the pack.

The demand for pomegranates is very unstable as yet, and markets are easily glutted. This is largely due to a lack of knowledge on the part of the great body of consumers as to the merits of the fruit, as well as to the fact that the pomegranate, still being used largely for decorative purposes, is regarded as a luxury. There is some demand for the fruit to be used for decorative purposes in presentation baskets of assorted fruits, in retail displays, on banquet tables, and in preparing various kinds of punch. This kind of demand is almost entirely from American consumers in eastern markets, where nearly all the commercial pomegranate crop is disposed of. Such markets as Chicago, New York, and Philadelphia take small shipments of good fruit regularly at very satisfactory prices.

A few people in the east, particularly Greeks and Slavonians, buy the fruit for eating out of hand. The markets in Los Angeles and San Francisco are quite limited and easily oversupplied. Here the fruit is but little used for decorative purposes, being consumed chiefly by Indians, Mexicans, and people from the Mediterranean countries, who eat the fruit out of hand.

Pomegranates are often dispatched by the carload lot, but a common practice is to include a few boxes in a carload of oranges or

Emperor grapes. This practice avoids overloading a market and fruit shipped in this way rarely fails to bring fair prices.

If picked with long stems and hung up to cure in a dry room, pomegranates will keep in very good condition for several months. The rind dries and hardens, but the interior remains good and even improves. The farmers in Algeria cure large quantities of pomegranates in this manner every year. Since the fruit keeps so well there seems to be no reason why the market should not be supplied with them for from six to eight months of the year.

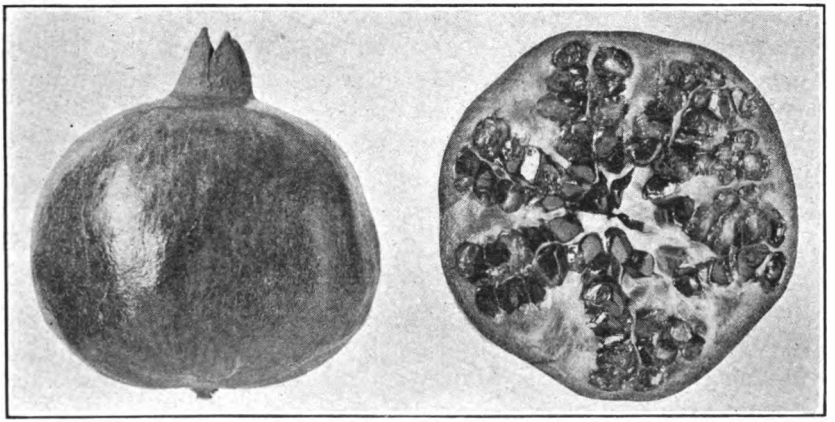

Fig. 12.—The Wonderful pomegranate after five months in cold storage.

YIELDS AND RETURNS

As has been brought out in previous statements, a great variation in yields has been reported by different growers. Orchards situated on sandy soils are found to bear light crops. Heavily pruned trees are noticed to bear small crops. We may then conclude that yield is influenced, primarily, by the nature of the soil and, secondarily, by the method of pruning practiced. The various combinations of these two give rise to a wide range of variation in yields. Individual trees are known which bear regularly ten to fifteen packed boxes.

Prices received on California markets do not run as high as those obtained in Eastern cities. The price on the San Francisco market fluctuates from 65 cents to $1.50 per box during the season, averaging 75 to 80 cents. Pomegranates retail at relatively high prices in California. In the San Francisco Bay region in early season the fruit retails at three for 25 cents, later at 5 cents apiece, and rarely goes lower than three for 10 cents.

A study of the prices realized for California pomegranates sold at auction in the Chicago market, Monday, October 25, 1915, is interesting. On that day there were unloaded and sold 320 boxes of pomegranates in seven lots. The highest price received was $2.50 per half-box. The fruit bringing this price was packed in two layers, thirty-two fruits per box. This is one of the largest sizes packed. The lowest price received for an undamaged box was $1.35. This fruit was packed in three layers, ninety fruits per box. Other fruit packed seventy-six fruits per box and one hundred and six fruits per box brought $1.40. The total receipts for these 320 boxes were $480.60, making the average price $1.50 per 36-pound box.

According to the census figures for 1910, the average net price returned to the pomegranate grower in the United States is 3 cents per pound, which would be about $1.00 per box.

A good pomegranate tree should yield 250 pounds of marketable fruit. This amount will pack seven half-boxes. Using the average net returns for last season, this tree would return the grower $5.95 per season. The cultural costs are low, but assuming these to be $75.00 per acre and that there were 100 trees to the acre, the returns from a first-class orchard would amount to approximately $500.00 per acre. This figure seems high and does not represent the average, but some growers have reported such returns and claim that their pomegranates are more profitable than their oranges. It should be borne in mind, however, that the total market demand is yet small and does not justify a rapid or sudden extension of pomegranate planting. As the demand is growing we may confidently expect a gradual and permanent increase, especially if the growers limit shipments to first-class fruit which will advertise itself and thus increase the demand.

USES

At the present time the pomegranate is used chiefly in eastern markets for decorating fruit stands and banquet tables. Fruit retailers also find that the pomegranate is useful in increasing their variety of fruits and in attracting the attention of buyers. It is also useful in the preparation of mixed gift baskets of assorted fruits. The red arils and crimson juice are used to some extent in salads, punches, and fancy dishes. In the southwest, however, by far the greater proportion of the fruit is eaten fresh out of hand.

The sweet pomegranate, the only sort grown for market, when perfect, possesses a fresh crispness, delicacy, and sprightliness of flavor almost unrivaled among fruits. It is deemed a great luxury by those

who are accustomed to it in its perfection. There is a knack in opening the fruit and shelling out the arils, which the novice only acquires with practice, but at which the Mexicans and southern Europeans are very dextrous (see Fig. 13).

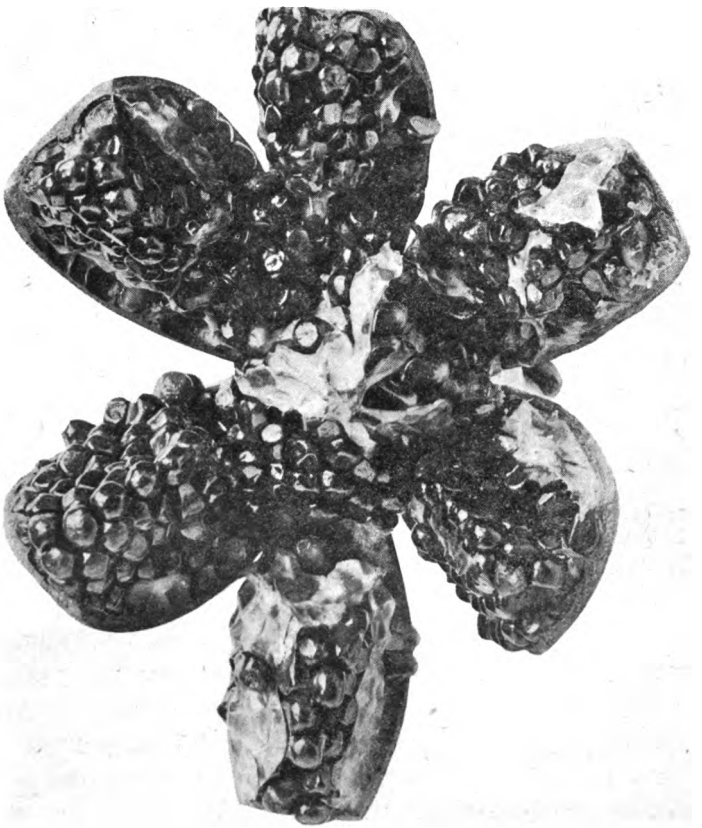

Fig. 13.—The knack of opening a pomegranate. A circular disc is cut from the calyx end, the rind divided into segments by following the partition walls, the segments forced apart and the arils shelled out.

In Syria the fruit is cut open, the arils are extracted and stewed with sugar, sprinkled with rose water, and served on little plates, this being considered a dish of rare excellence.

From ancient times the Mediterranean peoples have used the pulp in making acescent and cooling drinks. The juice is particularly satisfying during fevers or in hot weather, assuaging thirst to a marked degree. An infusion of the crushed seeds in cool sweetened water is greatly appreciated by convalescents. The pomegranate is

considered superior to the lemon for summer drinks, by many people. The inhabitants of southern Russia and Armenia make a commercial drink called Nasharab from the juice which is said to be very good.

A very delicate wine was prepared from pomegranate juice by the ancient Jews. Grath Rimmon, the name of a certain village, signifies Press of the Pomegranate. In France the juice is mixed in certain proportions with grape juice and a wine made which is highly esteemed. The Balkan peoples manufacture a wine from the pomegranate, which constitutes an important industry in those countries. Professor W. V. Cruess of the University of California has made a good grade of wine and a fair claret from pomegranate juice.

The pomegranate is coming more and more to be regarded as a fruit of great possibilities for use in the soft drink trade. For this use its chief value lies in its high juice content. The flavor is strikingly sweet and aromatic, and the color of red varieties is beautiful crimson. The acid content, chiefly citric, is small, about 0.6 to 1.0 per cent, or similar to that of sweet strawberries. The sugar content of the juice varies from about 12 to 17 per cent. There is an aromatic principle, not volatile or capable of distillation, which seems to be contained in the extractive matters. In good pomegranates the juice yield is about 75 per cent of the weight of the fruit, or sixty to seventy-five gallons per ton. The seeds average 7 to 8 per cent of the weight of the fruit.

Analyses of the fruit by the California Station in 1903 and by the Hawaiian Agricultural Experiment Station in 1913 show: Edible portion, 56 per cent; water, 76.8; protein, 1.5; fat, 3; sugar 14 to 16; crude fiber, 3 to 4; ash, .6. It is interesting to note that pomegranates contain more sugar than apricots, plums, peaches, or oranges.

Considerable difficulty is encountered in expressing the juice, as the rind is bitter, containing tannin, and ordinary crushing methods cannot be used. At present, the fruit must be cut open and the arils removed for pressing. If varieties of pomegranates can be procured by breeding or introduction which have little pulp and thin rinds and are relatively low in tannin content, it is entirely possible that a process of extracting the tannin may be worked out so that the necessity of laboriously removing the arils before crushing may be obviated. The juice, when cooked with an equal amount of sugar, produces a beautiful red-colored syrup which is greatly improved by the addition of a little lemon syrup. This serves to bring out the aromatic flavor and increase the acidity. A syrup of this nature constituted the original grenadine syrup, much used in Europe in the preparation of soft

drinks. Very refreshing carbonated drinks, equal to any of our common carbonated beverages, can be made by using this syrup as the base. Confectioners sometimes use the red juice of the Wonderful variety for coloring candies, ice cream, and other things.

Pomegranate juice, when sterilized in its natural form and preserved in bottles, is excellent, and in the opinion of many, equal to the best grape juice. It does not possess that cloying sweetness which so many people object to in grape juice made from European varieties.

Jellies and preserves can be made from the pomegranate if a little orange or lemon peel is added to furnish the pectin.

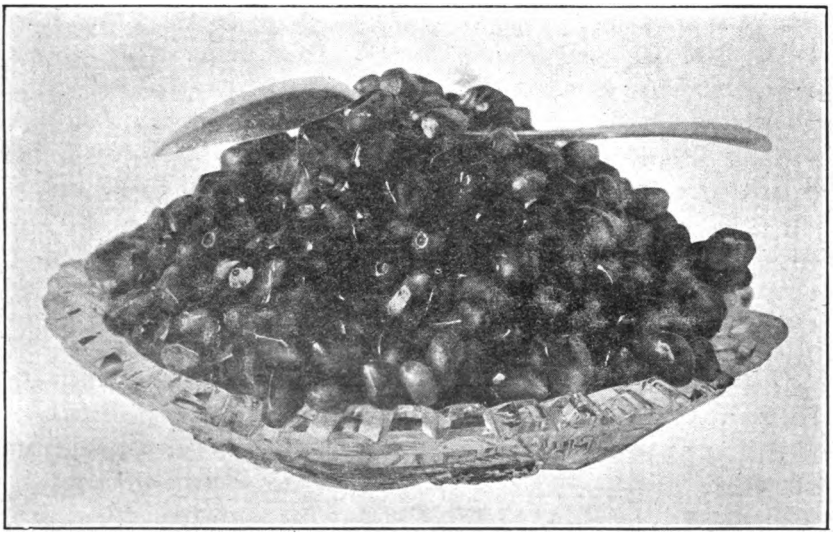

Fig. 14.—The arils from a single fruit make a highly attractive dish. (Reduced.)

A dye is extracted from the bark which is used in staining morocco leather. The flowers furnish a pale yellowish-red dye while the rind of the fruit yields a jet-black indelible ink.

DISEASES AND INSECT PESTS

The pomegranate has been singularly free from diseases of any economic importance. Indeed, most growers claim that their trees are absolutely free from disease. However, there has recently appeared a new disease which may prove a limiting factor in pomegranate culture.

Heart Rot.—When an infected fruit is opened, the central cavity is found filled with a disgusting mass of decayed arils, black in color

and disagreeable in odor. The decay usually shows no connection with the rind, being entirely surrounded by sound flesh. It is sometimes quite difficult to detect infected fruit from exterior appearances, although experienced pickers are able to discard most of the infected fruits as it is imperative that they be excluded from commercial packs. Infection takes place in the blossom and the progress of the fungus may be traced by a thread-like black line of decay from the stigma down through the stylar canal into the interior of the fruit.

Coit found this rot interfering with the shipping of pomegranates at Mesa, Arizona, as early as 1907. In 1910 Kearney reported it from Indio, California, Sacaton and Phoenix, Arizona, and San Antonio, Texas. Recently specimens have been received at Berkeley from various parts of the San Joaquin Valley. Here at Berkeley various persons in the Divisions of Plant Pathology and Citriculture have made cultures repeatedly over a period of several years with the uniform result of finding an alternaria present in pure culture in the interior of the fruits. And yet this rot is apparently the same as that studied by McMurran* of the United States Department of Agriculture and reported as due to *Sterigmatocystis castanea* Patterson.

At present no remedy can be suggested except the sanitary precaution of gathering and burning all rotten fruits found about the orchards.

There is no insect which seriously infests the pomegranate in California. A few isolated instances where a single tree has been attacked by some insect have been reported. In no case, however, has the damage been severe enough to warrant any control measures.

Aspidiotus camelliae (*Greedy Scale.*)—The pomegranate has been reported attacked by the greedy scale in Los Angeles County. However, the damage done has been very slight and but few infested trees have been reported.

Coccus citricola (*Citricola Scale*).—Near Porterville an orange orchard infested with this scale joined a pomegranate orchard. The row of pomegranates next the oranges was rather heavily infested with scale, but there appeared to be little tendency for the scale to spread from the row next the oranges where they had probably been blown by the wind.

Scirtothrips Citri (*Citrus Thrips*).—A peculiar rolling of the edges of the leaves frequently noticed, but not understood, has recently been found to be due to thrips. Sometimes the fruit also is scarred, but ordinarily the damage amounts to little. In midsummer

* Phytopathology, vol. 2, no. 3, p. 125.

the thrips concentrate on the tender growth of the new suckers from the roots, causing serious damage to the leaves or complete defoliation of certain portions of the shoots. As the suckers are all removed during the next pruning season the harm done is negligible. It has not been found necessary as yet to employ any control measures.

Virachola Deudorix livia (*Pomegranate Butterfly*).—This insect has been reported by Woodrow in India and by Gough in Egypt. The larva or caterpillar does the damage, infesting the interior of the fruit. The proportion of the crop attacked is quite large and the damage is very serious.

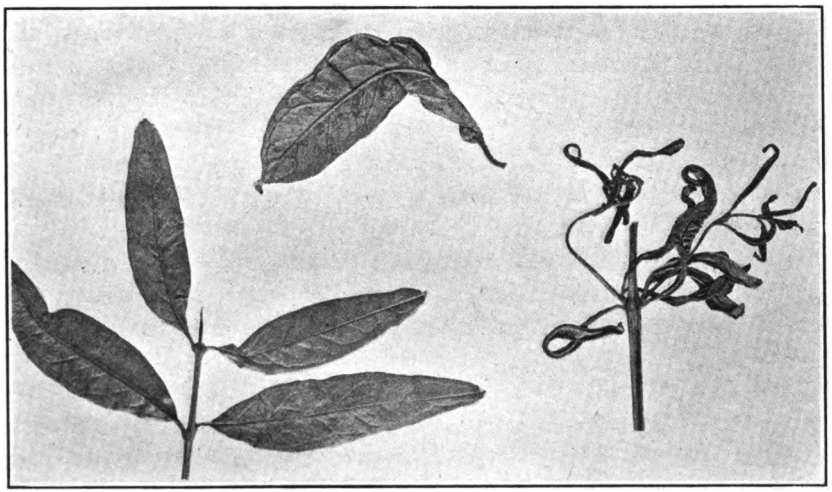

Fig. 15.—Pomegranate leaves distorted by citrus thrips contrasted with normal leaves.

Leptoglossus Zonatus.—This insect, a large sucking bug, is reported in the Salt River Valley of Arizona as causing considerable damage to pomegranates as well as oranges and other fruits. The bug is about three-fourths of an inch long and gray in color. The mouth parts include a long tube, which is used for sucking. The insect excretes a dark liquid which has the very disagreeable odor so characteristic of the stink-bug family.

While very little accurate information is available as to the damage caused by this bug, it is known to breed in great numbers on the pomegranate bushes and to suck the juice from the exposed arils of split pomegranates.

In Hawaii the Mediterranean fruit fly, *Ceratitis capitata,* is known to attack pomegranates.

OTHER TROUBLES

Splitting.—At the ripening period the pomegranate is very subject to splitting. This is a natural characteristic of the fruit but is much more pronounced in some cases than in others. It varies with locality, variety, and even in individual trees. There are two characteristic kinds of splits, stem-end splits and side splits.

Many explanations have been advanced to account for the splitting. It has been attributed to early frosts, early rains, irregular irrigation, light irrigation, and many other things. The common idea is that splitting is due to sudden fluctuations in the moisture content of the soil and air, caused by a lack of irrigation at the proper times, or hot, dry north winds followed by heavy irrigation. Splitting is always worse in the case of fruit which is allowed to become overmature on the trees.

While quite severe in some sections, very little definite information is available as to the causes of splitting. There are varieties or strains which are not seriously affected. The trouble may be largely avoided by picking the fruit before splitting becomes serious.

Sun-scald or Sunburn.—Fruits exposed to the direct rays of the sun in very hot, dry regions are occasionally sunburned. This is evidenced by a dark brown color and a very tough, leathery condition of the rind on the side affected. Sunburn causes the fruits to be irregular and uneven in growth, but is usually not of any great importance.

Internal Breakdown.—The fruit from certain districts in some seasons is affected with a peculiar condition of the arils resembling that breakdown or deterioration which normally occurs during senile decline. This condition may be found in fruit still hanging on the tree early in the season, when it should normally be at the height of its life activities. The arils have a lighter color than is natural, are rather flat in taste and exhibit a streaked appearance. Many delicate white lines radiating in all directions from the seed to the outer wall of the aril can be seen. It appears to be an enzymatic deterioration, as no organism has so far been found in connection with it. There is apparently no way of determining from the external appearance of the fruit whether or not it is affected with this trouble. We can only compare it with the internal browning of certain kinds of apples and say that both are probably physiological diseases, the nature of which are not as yet understood.