Issued February 4, 1918.

PORTO RICO AGRICULTURAL EXPERIMENT STATION,
D. W. MAY, Agronomist in Charge.
MAYAGUEZ, P. R.

Bulletin No. 24.

THE MANGO IN PORTO RICO.

BY

C. F. KINMAN,
Horticulturist.

UNDER THE SUPERVISION OF
STATES RELATIONS SERVICE,
Office of Experiment Stations.
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PORTO RICO AGRICULTURAL EXPERIMENT STATION.

[Under the supervision of A. C. TRUE, Director of the States Relations Service, United States Department of Agriculture.]

E. W. ALLEN, *Chief of Office of Experiment Stations.*
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LETTER OF TRANSMITTAL.

PORTO RICO AGRICULTURAL EXPERIMENT STATION,
Mayaguez, P. R., March 31, 1917.

SIR: I have the honor to submit herewith a manuscript on the Mango in Porto Rico, by C. F. Kinman, horticulturist. The information embodied in this report gives the results of painstaking efforts through several years to introduce and propagate improved mangoes. These results indicate that the mango will take an important place in the Porto Rican fruit industry, which has made phenomenal progress during the past decade. I recommend that this manuscript be issued as Bulletin No. 24 of this station.

Respectfully,

D. W. MAY,
Agronomist in Charge.

Dr. A. C. TRUE,
Director States Relations Service,
United States Department of Agriculture, Washington, D. C.

Recommended for publication.
A. C. TRUE, *Director.*

Publication authorized.
D. F. HOUSTON,
Secretary of Agriculture.

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[1] On leave.

THE MANGO IN PORTO RICO.

CONTENTS.

INTRODUCTION.

The mango industry in Porto Rico has developed practically without attention or interest on the part of the inhabitants, although the fruit is one of the most important of the island, as it is of most tropical countries. The common types, all of which grow without cultivation, are as a rule prolific, the fruit of the best sorts being free from serious insect pests and diseases, but all are of ordinary or poor flavor with an abundance of objectionable fiber in the flesh. With few exceptions the fruits are small, and this, together with their poor keeping qualities, makes them unsatisfactory as a commercial crop.

The production of the superior varieties of mangoes, notably those from India and the East Indies, is a new industry but one worthy of greatly increased interest in Porto Rico, as the climate and soils are suitable and the best markets of the United States may be reached within a very few days. Home markets for this fruit could be quickly developed also, as the liking for the mango is universal among the inhabitants of the island and large quantities of the common types are consumed as soon as they are ripe enough to be edible.

The problems confronting the commercial production of superior mangoes here are in many respects those of a new industry. Methods of asexual propagation are not known among the planters, but chance seedlings happening to spring up in desirable places are protected to furnish the future supply of fruit. The trees have not been cultivated nor the suitability of the soil tested. The present method of marketing is to shake the crop from the tree and to load it loosely into cars or wagons for transportation to local markets or those in other parts of the island. Tests with fruits of superior

varieties show that they will keep longer after harvest than common kinds, but that they must be handled carefully in order to reach distant markets in attractive condition. There is a wide difference between varieties in vigor of trees and in size and quality of fruit, and as the general conditions in Porto Rico are suited to the production of this fruit, the proper selection of varieties for planting seems to be the most important consideration. The success of an orchard will depend mainly upon the planting of prolific varieties suited to the locality and with fruit of a size and quality to command a ready market.

As the observations here reported are drawn from the work of several years during which trees of many varieties have been imported, propagated, and in some cases brought into satisfactory production, they should prove of value to those who expect to plant mangoes for sale or for home use. Over 40 varieties which have not yet fruited will be discussed in subsequent reports.

SOIL.

Porto Rico has a very wide range of soil types, a given type, however, occurring in only small areas in any section. As the mango tree is found in abundance in almost all parts of Porto Rico, the quality of soil in which it is planted seems to be an unimportant factor in its growth, provided the depth of the soil is considerable. A shallow soil underlain with stone or hardpan, although sufficiently deep to produce shrubs or other low-growing wild vegetation, will not satisfy the needs of the deep-rooted mango, whose growth in such ground will be slow and its yield poor, at least after the first few years. The application of fertilizers, however, will materially decrease the depth of soil required. While the mango is less affected by the quality of the soil than many other fruit trees, it is sensitive to an overabundance of soil moisture. It is never vigorous or prolific in low, poorly drained lands or on higher planes where the water level is near the surface throughout long periods. Where subdrainage is poor, the vigorous roots which penetrate to some depth during a dry season are always severely injured if not killed by the excess of water during the period of heavy rains lasting for several months each year in almost all parts of Porto Rico. Subdrainage is generally poor through the rolling districts and also in the western part of the island where the mango is most plentiful, though, in the latter district practically all of the mango trees are found growing at the brink of steep hillsides, on short, narrow knolls and ridges, near road cuts or on grades, etc. A ditch only 2 or 3 feet deep will often cause a tree growing at its edge to make a normal-growth and bear good crops. Where the soil is loose, with

good filtration of water, large and prolific trees may be found on level land or even in depressions where water remains above the surface a few hours after heavy rains. Mango trees are often found on very light, unfertile sand, which may be a few feet in depth and still produce flourishing growth if the subsoil is suitable. As the mango, like most other fruit trees, thrives best on a deep, loose loam with good drainage and a high percentage of humus, those who intend planting it commercially should secure, if possible, this type of soil. Imported mango trees planted on such land in Porto Rico have reached a height of 26 feet and a spread of 34 feet in 12 years, while others of the same variety, receiving an equal amount of rainfall but growing in a soil with poor subdrainage, are at the same age 16 feet tall and 21 feet in spread. However, the latter have been more prolific.

CLIMATE.

The temperature in Porto Rico is well suited to the production of mangoes, for, as in other islands in this region, it is swept by warm trade wind and sea breezes which keep it always warm enough for the best growth of the trees. This is especially true in the low-lying districts, those which lie between the sea and the mountains of the interior having an average daily maximum temperature varying from 84° F. in winter to 89° in summer and a minimum from 66° F. in winter to 73° in summer, an excellent temperature for the mango, which is more tropical than subtropical in its needs. Through the interior of the island the temperature averages from 2° to 3° cooler during the day and from 5° to 6° cooler at night. At the highest elevations, a number of which are over 2,000 feet, the temperature during the coldest months is occasionally in the lower fifties. Here the mango trees grow well but fruit very poorly, the small crops probably resulting directly from the temperature.

While the temperature is even and satisfactory, the rainfall and general humidity vary considerably in different districts. In some places, especially through the interior and along the northern slopes, the rainfall is too great during the mango blossoming season for the best fruit production. Along the western and southern coasts the greater part of the year's rainfall occurs during summer and fall, and during late winter and spring the rainfall is always light and the drought usually severe. Here the crop of mangoes is almost invariably heavy. The trees make a satisfactory growth unless the drought is very long and severe, as they are capable of thriving on rather slight moisture as well as of withstanding a little excess moisture without visible injury.

Where the drainage is good the only time at which the rains have proved detrimental is while the trees are blossoming. Rains are

always injurious to mango flowers, as they wash away the pollen, injure the stigma, and cause the pollen to remain damp, thereby improving conditions for the growth of the anthracnose fungus which is so destructive to the blossoms. The mechanical injury is easily effected, for the one pollen-bearing stamen and the prominent pistil are not protected by the small, widely divergent petals. The moistening of the pollen by the intermittent rains and low clouds, which drift for some distance down the slopes of the highest hills of Porto Rico, encourages the growth of the blossom-destroying fungus, and this, together with the mechanical injury due to the heavy rainfall in these sections during the mango blossoming season, is probably responsible for the low yields and frequent fruit failures.

The importance of moisture conditions should not be overlooked in planting mangoes. Fortunately for the prospective orchardist the rainfall in Porto Rico for corresponding months in different years varies little, this constancy permitting the selection of a locality where the mango blossoms during a season of light rainfall. Where irrigation water is obtainable, a dry section would prove most satisfactory as the blossoms would set fruit regularly and the fruiting tendency could be encouraged by the proper application of water.

The effect of wind on mango blossoms is also probably important, although seldom referred to. Its stimulating effect may induce blossoming and its drying effect no doubt enables this fruit to set. For a number of consecutive seasons it has been noted at Mayaguez that trees situated in exposed places always bear more heavily on the branches facing the prevailing winds, often producing a large percentage of their crop on the windward side. The drying action of the wind probably protects the blossoms from fungus attack, since the windward side of the tree is dry much earlier in the morning than the leeward side or than trees in low, wooded, or otherwise protected places, where the heavy tropical dews remain on the leaves until late in the forenoon. As the prevailing winds during February and March, the principal mango blossoming season, are from the northeast, the morning sun may be as necessary as the winds for inducing blossoming, although the section of the tree facing the wind is more prolific than that exposed directly to the morning sun, which is south of east at this season. The stimulating effect of wind on the growth of the branches is probably an important factor in the production of blossoms, as the wood growth and inflorescence are much heavier on the side of the tree facing the wind than on other portions, sometimes causing a very one-sided development (Pl. I, fig. 1). This effect is more pronounced on imported varieties than on uncultivated Porto Rican types and more so on some of the imported varieties than on others. Those which afford the most

striking examples of this in both growth and fruit production are Bennett, Paheri, Sandersha, and Cambodiana. While newly placed buds and grafts and small trees just transplanted should be protected from strong drying winds, the orchard site should be well exposed to the prevailing winds and morning sun.

BLOSSOMING.

Although in some parts of Porto Rico climatic conditions are not favorable to the setting of a crop of fruit, the mango is well adapted for fruit production, as it blossoms at intervals throughout the spring and thereby improves its chances of meeting suitable weather for pollination. From observations already made, it appears that the imported kinds have a longer blossoming season than the common sorts, as some of them bloom almost continuously for ten or more weeks when conditions do not permit the setting of a crop before the end of that time. To this class belong Sandersha, Totafari, and Amini, a single tree of the first having blossomed as early as December 10 and as late as May 10 the following spring, with the production of two heavy crops and a number of light crops of blossoms during the intervening time. Cambodiana, Bennett, Bulbulchasm, Sufaida, and others are varieties with long blossoming seasons.

In the southern and western portions of the island the mango-ripening season is usually much longer than in other sections, as the drought which occurs during the late winter favors the fertilization of early and late blossoms. Under normal conditions only a very small percentage of the early blossoms produce fruit, while good crops have resulted from extremely late blossoms. As few varieties have been cultivated in Porto Rico over a long enough period to determine blossoming habits, close attention should be given the untested kinds and a careful selection made based on these habits before an extensive planting is made.

Where mango trees grow vigorously, as in nearly all parts of Porto Rico, they are inclined to bear no crop or very small ones for a season or more after they are of sufficient size and age to produce heavily. Varieties or individual trees which do not bear when sufficiently mature may be induced to blossom by any of a number of methods. Girdling, branch pruning, and root pruning are common practices, but they should be used with caution and moderation, as a tree may easily be so severely injured as to prevent its bearing for one or more seasons. Pruning back the ends of the branches to induce blossoming has been practiced with good results at the station. In the operation, from a few inches to a foot of the end of the branch was removed, depending upon the stage of maturity of the

wood, leaving a few nodes from which the leaves had not fallen. From these nodes blossoms developed profusely, no blossoms appearing on untreated branches. To secure best results, the pruning should be done in the late summer or fall, several months before the blossoming time. This method should be employed on branches which are too low or too crowded or on those which would have to be removed later to improve the shape of the tree, as after a branch is pruned, it makes little growth for several weeks or months or even for a year or more after the fruit ripens, and by this time it may be well overgrown by surrounding branches.

As good results have been obtained from girdling as from other methods. A branch 1 to 3 inches in diameter was selected on each of a number of trees and a band of bark removed in September. These branches produced good crops in the following spring, even when no fruits at all were borne on the remainder of the tree. Such favorable results, however, were obtained on varieties which are inclined to bear well and where the band of bark removed was wide enough to prevent the new bark from growing over the area too rapidly. Bands one-eighth and even one-quarter of an inch in diameter were overgrown so quickly that no effect was seen on the branch. Bands from one-half to three-quarters of an inch produce the best results, as they do not heal over until after the blossoming season, the callus growing downward over the wound at the rate of 1 inch a year. The photograph in Plate II, figure 1, was taken in April and shows a branch of Paheri, from which a band of bark 1½ inches in width was taken in September. This branch bore 39 fruits of extra large size and was the only branch of the tree to bear. The effect on Cambodiana, Bennett, and Amini was equally striking. Girdling the branches of 10-year-old trees of Davy's and Madras, varieties which have so far been very unproductive, some of the trees having never borne, did not induce fruiting. As removing enough bark to induce fruiting is very injurious to the branch, this practice is most profitably employed on undesirable branches which are to be removed later.

Root pruning has been recommended, although no definite results have been noted from experiments with it. It is best accomplished by cutting into the soil with a sharp spade about 2 feet inside the tips of the branches. In extreme cases the cutting may encircle the tree to a depth of 8 to 10 inches in heavy soil and even deeper in light soil where the root system is considerably below the surface. Cutting at such intervals as to sever the roots for one-half to two-thirds of the distance around the tree will induce blossoming under normal conditions without seriously checking the growth or thrift of the tree.

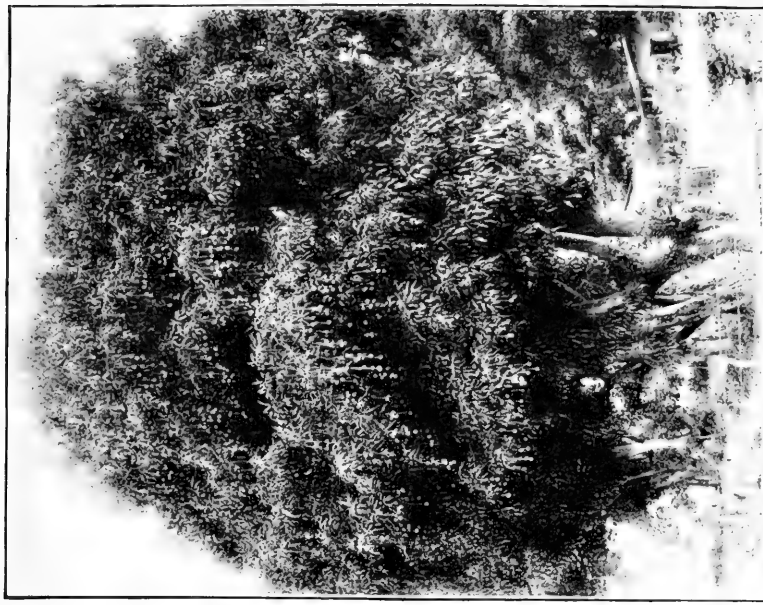

FIG. 2.—AN OLD BLANCO MANGO TREE IN FRUIT.

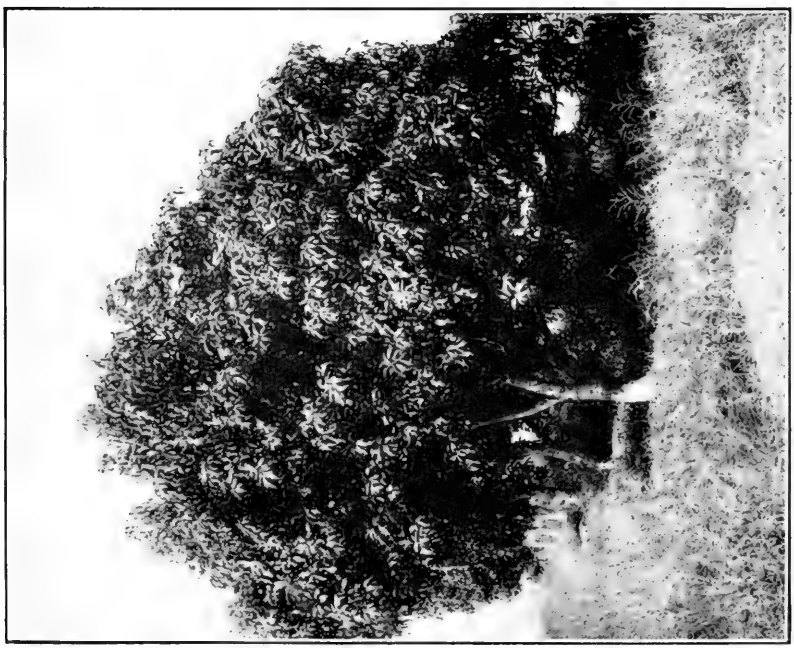

FIG. 1.—MANGO TREE WITH HEAVY WOOD GROWTH ON WINDWARD SIDE.

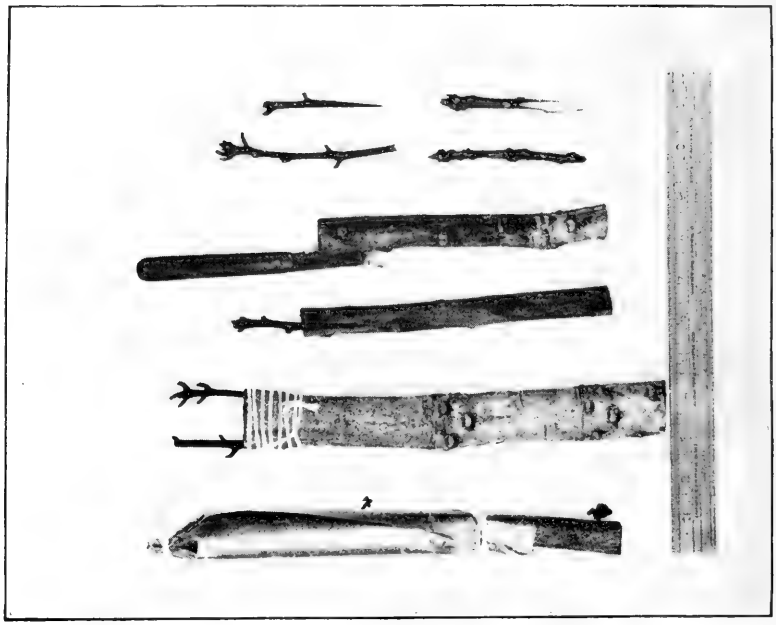

FIG. 2.—BARK GRAFTING THE MANGO.

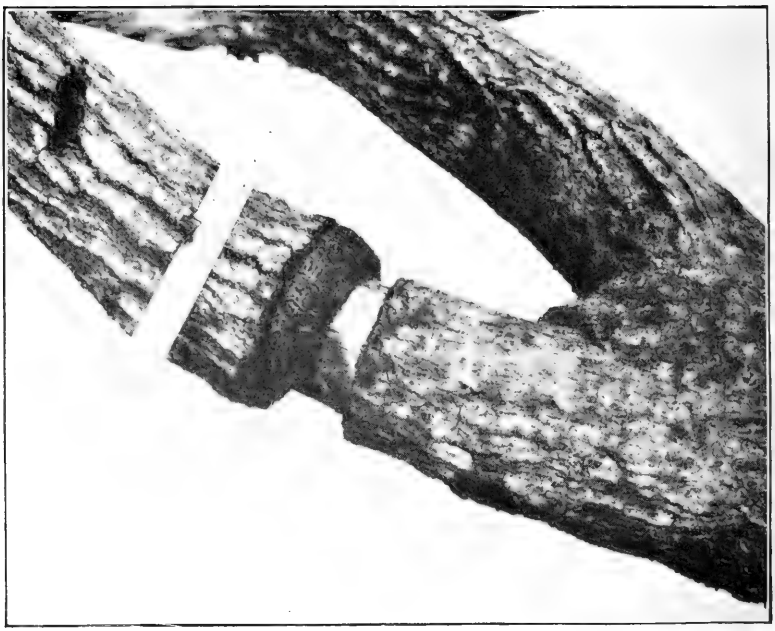

FIG. 1.—A MANGO BRANCH 7 MONTHS AFTER GIRDLING.

PROPAGATION.

Where it is desired to reproduce the qualities of the parent tree, simple and satisfactory methods for general use in mango propagation are inarching, or approach grafting, and bark grafting. Seedling trees of Cambodiana and a few other types will, it is claimed, produce fruit very similar to that of the parent and sufficiently uniform for orchard use, but seedlings should not be used for general planting until more information regarding the habits of the different types has been secured.

When any of the asexual methods of propagation are used, success in the work and development of the tree will depend mainly upon the seedling stock. To secure good stocks seed just taken from the fruit or those which have been removed only a few days should be used, as the seed lose their viability quickly and are very liable to decay after being removed from the fruits. To insure prompt germination and normal plants the seed should be husked before planting, care being taken not to injure them in any way. This may be quickly done by peeling off with a sharp knife a narrow strip of the husk which may then be readily opened. The husks of many of the East Indian varieties are very thin and easily removed, but those of the uncultivated Porto Rican types are very thick and tough and their removal difficult. Delay in growth and injury to plants are proportionately greater where the seed coat is not taken off.

To test the effect of taking off the husk three lots of 100 seeds each were planted, one with the husks removed, one with the husks cut on one side, and one with the husks entire. The seeds, all very uniform as to size and shape, had been taken from uniform fruits of the native variety Blanco, which has a very thick seed coat, and planted immediately after removal from the fruit. The following table gives the detailed record of the germination:

Effect of different seed treatments on germination.

Number of days after planting.	Percentage of seeds germinated.		
	Husked.	Opened on one side.	Unhusked.
10	94	18	None.
17	98	68	14
24	98	74	38
31	98	88	86
38	98	90	86

This shows not only that the total number of husked seed germinated was somewhat greater than of unhusked seed but that the time required for germination was much shorter. Where the husks were

not removed, the development of the plants was, in the majority of the cases, hindered, often so severely that they were discarded as valueless. Plate III shows plants of the same age from plantings of husked and unhusked seed, one an extreme specimen from an unhusked seed which is typical of about 30 per cent of the plants from seed planted in this manner (fig. 1, center).

Kernels which produce a single plant are preferable to those sending up a number of plants, as the seedlings are more thrifty and vigorous and are ready for use as stocks in a short time, while where a number of seedlings are produced they are very slender and slow growing and in many cases never become satisfactory for working. Among the wild Porto Rican types grown, Rosa and Redondo seldom produced more than one seedling, while all of the other more common ones produced two or more. The seedlings of East Indian varieties produce large thrifty plants which are preferable as stocks, as they grow faster than the Porto Rican kinds, and during the few years they have been under observation no undesirable qualities have been noted. Among the varieties tested Sandersha, Totafari, Alphonse, and Amini produce only one plant per seed and are most satisfactory as stocks. Cambodiana seedlings are vigorous, but, as from two to seven plants grow from a single seed, care must be taken to remove all but one of the seedlings soon after they appear, if a good stock plant is desired.

Whether the seeds are planted in pots or in the nursery the soil should be a rich loam with plenty of sand to insure good drainage, for if the growth of the seedling is checked by lack of food or excess of soil moisture it will be permanently injured and often will not recover its vigor sufficiently to be of value as a stock. The seeds require shallow planting to prevent suffocation.

GRAFTING.

When seedlings are somewhat thicker than a lead pencil (about $\frac{3}{8}$ inch in diameter) and the bark has assumed a grayish color (about seven months after planting the seed) they are of a convenient size for grafting. Then as soon as they make a flush—that is, as soon as they are in a growing condition and the new red leaves are just appearing—they are ready for use. If the plants are thrifty they will remain in good condition for several days and often two weeks.

Branches must be selected for scions which have not made a recent flush, but are just on the point of starting a new growth. Such tips have rather mature wood and the buds nearest the end are swollen but not quite ready to open into growth. They should be cut below the third or fourth node. If any of the buds just below this point, on wood of the same age, are swollen preparatory to opening, the sec-

tion bearing them will also be satisfactory and sometimes more desirable than the tip section for grafting, as this wood is often better developed. If at the time the stocks are just starting a new growth there are no branch tips suitable for scions, the upper axillary buds can often be forced into condition in a week or more by cutting off the tips of the branches.

To make the graft the seedling should be cut off by a smooth transverse stroke a few inches above the crown, a perpendicular slit about an inch in length being cut barely through the bark on one side of the upper end of the remaining stump (Pl. II, fig. 2). The scion, which is prepared by cutting the lower end with a smooth slanting surface about an inch in length having a sharp, wedge-shaped point, is then forced gently down under the lips of the slit in the bark of the stock. The scion should be fitted firmly into place in order to have the cambium of the stock and scion in close contact over as long a surface as possible. To hold the scion in place a cotton string is wound firmly around the graft, commencing at the top of the stock to prevent forcing the scion out of place. A waterproof paper should then be wrapped around the scion and the upper end of the stock and folded over the top of the scion to secure fairly uniform humidity and to prevent an excess of moisture from entering and causing decay. It is important to perform the operation rapidly enough to prevent any drying of the cut surfaces.

In about three weeks the scions should have started growth. The paper should then be removed, as it is injurious to the new growth, and the cotton string used for binding the scion should be cut as soon as the union is well formed.

INARCHING.

When it is planned to propagate by inarching, the seedling to be used as a stock should be in a large pot (Pl. III, fig. 2) or box. To secure a good stock it is best to plant the seed in the receptacle to be used rather than to attempt to transplant young seedlings. Although the success of the operation does not depend so entirely as in grafting upon the condition of the stock and scion, these should be as nearly as possible in the same stages of growth as for grafting and the seedlings should be about the same size and age as those for grafting if outdoor work is practiced. For indoor work, where moisture can be controlled, or in the orchard if climatic conditions are favorable, botlr seedling and scion need be only a few weeks old. A very dry atmosphere and excessive wind, which are common in practically all sections of Porto Rico during parts of the year, make it impossible to use such young plants.

Before the operation is performed the seedling should be placed near the branch to be inarched, either on the ground or on a scaffold,

and the pot so fastened as to prevent disturbance by the winds. Then a thin strip of bark and wood from 3 to 5 inches in length should be removed with a sharp knife from the trunk of the seedling and one of similar shape from the scion, leaving a few inches of the end of the scion above the cut section. The cut surfaces are then placed together, so that the bark and cambium meet over as long an area as possible, and are tied firmly with cord or raffia. It is not necessary to apply grafting cloth, wax, or similar materials in inarching. At the time of inarching, the tip should be removed from the stock, and in three or four weeks the seedling should be cut back within one or two nodes of the union. When the union is well formed, the seedling should be cut off just above, and the inarched branch just below, the union. When the plant is cut from the parent tree it should be sheltered from the sun for a few days, then placed in partial shade a week or more and watered frequently. If weather conditions are favorable, it will be ready for planting in a permanent place in a few weeks.

TOP-WORKING OLD TREES.

There are thousands of large, thrifty, uncultivated mango trees growing in Porto Rico, some bearing almost worthless fruit and as many others producing fruit of poor quality, all of which could be grafted and made to bear superior fruit within a few years. (Pl. IV, fig. 1.) To accomplish this the branches should be cut back nearly to the trunk (Pl. IV, fig. 2), and when the new branches which spring from adventitious buds are sufficiently mature—that is, in 6 to 8 months—they may be grafted in the manner described above. Although a great number of new branches start from near the point where the old branches were removed, only the best of these should be selected for grafting, all the others being removed except a few near the grafts to protect these from wind and sun. While it is sometimes recommended to leave a few of the large branches when cutting back the old trees, this has been found unnecessary in Porto Rico, as better results have been obtained where all the branches were removed. Where large branches are allowed to remain, the new growth sent out from the stumps of the removed branches is always less vigorous and is not ready for grafting in very dry weather for several months after that on trees with all of the old branches removed.

A field nursery is seldom planted in the mango-growing countries, especially in the West Indies, but experiments with field nursery stock have proved the practicability of shipping the small trees short distances and have shown especially the value of a field nursery to growers who are planting a mango grove on their own fruit plantation. If the land is well prepared, the seedlings will make nearly if not fully as good a growth in the field nursery as in pots. The

FIG. 1.—MANGO SEEDLINGS; PLANT ON LEFT GROWN FROM SEED WITH HUSK REMOVED, OTHERS FROM SEED IN HUSK.

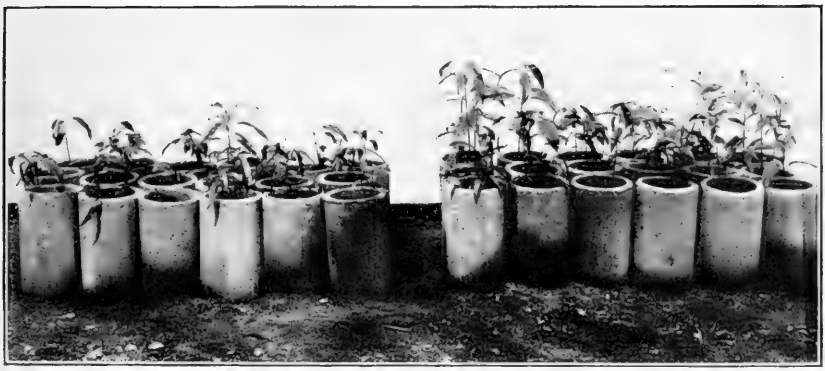

FIG. 2.—MANGO SEEDLINGS IN 6-INCH CONCRETE TILES; PLANTS ON LEFT GROWN FROM SEED IN HUSK, ON RIGHT FROM SEED WITH HUSK REMOVED.

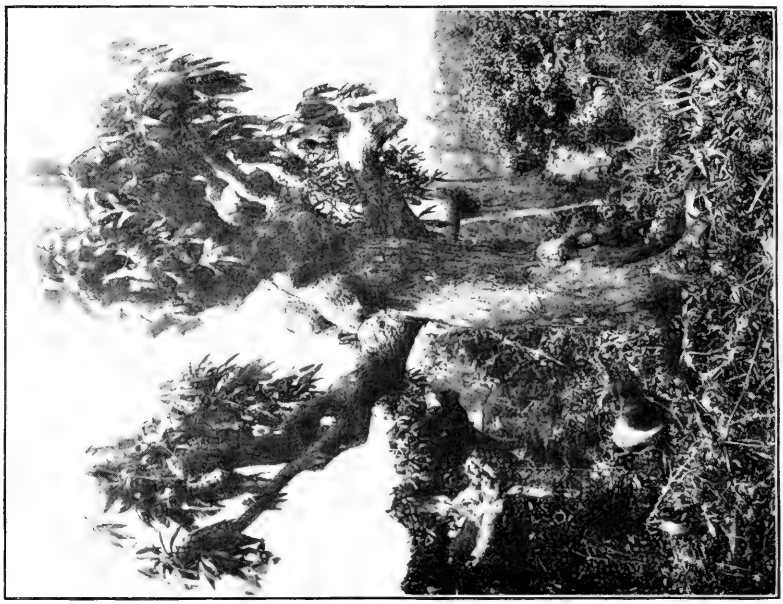

FIG. 2.—NATIVE MANGO TREE CUT BACK FOR TOP WORKING.

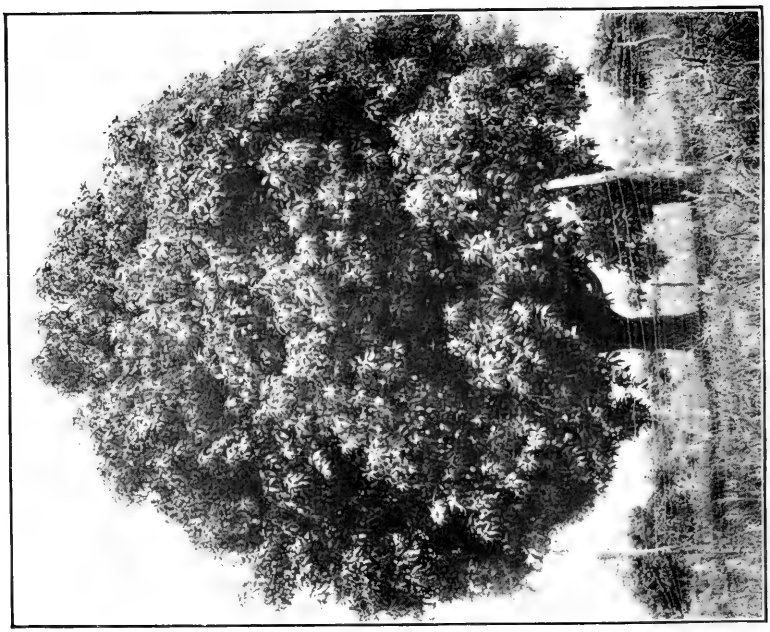

FIG. 1.—TOP-WORKED NATIVE MANGO TREE.

rows should be made 4 feet apart, with the plants 1½ feet apart in the row, to allow room for grafting and for the removal of a ball of earth with the roots in transplanting. Where the soil is not perfectly drained, as at the station, ridges sufficiently high to insure good drainage should be made. Only the largest and best seed should be planted. If the soil is fertile, an occasional cultivation will be the only care needed until grafting time—that is, in 7 to 9 months. Where all conditions are favorable, the grafted plants may be transplanted within a few weeks or, if desired, they may remain in the nursery for many months.

Mango trees may be successfully transplanted if rainfall is abundant or irrigation water is at hand and the branches are all well hardened. A large percentage of loss has resulted from transplanting when the trees were in a growing condition or the new growth was not well matured, although all branches were well cut back. In transplanting, a ball of earth should be removed with the tree and the top cut back severely. Where this practice was followed, not only nursery stock, but grafted trees of East Indian varieties with trunks from 4 to 6 inches in diameter which had borne two crops of fruit, were moved without loss. As newly transplanted trees are very susceptible to excessive moisture, they should, unless the subsoil is very well drained, be planted as high as they grew in the nursery, or higher. They must, however, be watered artificially if a drought occurs soon after transplanting.

IMPORTANCE OF CLASSIFICATION.

The present confusion in classification as to groups and varieties of mangoes is so great that, although considerable interest is being shown in the work, a long period will be required before a satisfactory adjustment is reached. As comparatively few imported varieties have so far fruited in Porto Rico no attempt at classification is made in this bulletin, only a detailed description of the fruit being given under the names received with trees from the United States Department of Agriculture and from other reliable sources. As the East Indian mango is almost unknown in Porto Rico except by name, and as there are few individuals who are familiar with any of the varieties the descriptions given below should be of value, since the cultivation of the mango will, doubtless, become important in a few years. The distinguishing characters of the several varieties are so pronounced that a knowledge of the differences is very important to merchants and planters who wish to satisfy the needs and fancies of domestic and foreign markets. Fortunately, most imported varieties are easily identified, there being a wide range of thrift and productiveness among them and still greater differences in the qualities of the fruits and the uses to which they can be put.

The tree is thrifty, but has been late in coming into full bearing. With a reputation gained elsewhere for poor keeping and shipping qualities this variety can not as yet be recommended for commercial planting at a long distance from a market.

Bulbulchasm.[1]—Fruits of this variety (Pl. VI, fig. 1) are kidney shaped or oblong with a nearly round cross section. A fruit weighing 1 pound is 5 inches long, 3⅛ inches wide, and 3 inches thick; 10 to 20 ounce fruits are not uncommon. The base is usually rounded with 3 to 5 shallow depressions extending outward from the stem; the ventral shoulder is more prominent than the dorsal. The nak is a dark russet speck situated 1 inch above the rounded apex and at the apex of a slightly raised V-shaped area; the surface is smooth, with a heavy white bloom; the color a dull yellow tinged with green and having a deep, purplish-red or bronze blush when grown in the sun; the dots generally light gray, small, and numerous toward the apex, those toward the base being larger and more scattered with russet centers; the skin thick but not tough, somewhat dry and tenacious though growing rather loosely over the flesh. These qualities prevent the fruit from being easily bruised.

The flesh is plentiful and smooth in texture, with fiber practically wanting; that near the skin is rich yellow in color and lacking in juice, while that near the seed is deeper yellow and more juicy. The flavor is sweet, rich, aromatic, and satisfying, and the quality is good.

The tree is low, round-topped, and dense, with a few main branches but numerous stout terminal branches, all of which grow at a wide angle from the parent branch. The leaf, heavy, tough, and dark green in color is 10 by 2 inches, with an acuminate tip. Trees of this variety produce fruit at an early age, are regular and fairly prolific bearers, and make a satisfactory growth for a few years; but a number of them under observation have developed large swellings at the points of branching and occasionally at internodes, which ultimately interfere with their development.

Cambodiana.[2]—The general form of Cambodiana (Pl. VI, fig. 2) is ovoid, with a depression along the lower half of the ventral side which makes it somewhat kidney-shaped. Both longitudinal and lateral cross sections are ovate, narrowing at the apex and ventral side. A representative marketable fruit weighing 10 ounces is 4⅜ inches long, 3 inches wide, and 2½ inches thick. There is much variation in weight of fruit, some specimens weighing 5 ounces, others 1 pound. The base is rounded and the ventral shoulder, which

[1] S. P. I. No. 9519. From Saharanpur, united provinces of Agra and Oudh, India. U. S. Dept. Agr., Bur. Plant Indus. Bul. 66 (1905), p. 285.

[2] S. P. I. No. 8701. From Saigon, Cochin China. U. S. Dept. Agr., Bur. Plant Indus. Bul. 66 (1905), p. 216.

FIG. 1.—BENNETT MANGO.

FIG. 2.—PAHERI MANGO.

FIG. 1.— BULBULCHASM MANGO.

FIG. 2.—CAMBODIANA MANGO.

FIG. 1.—DAVY'S MANGO.

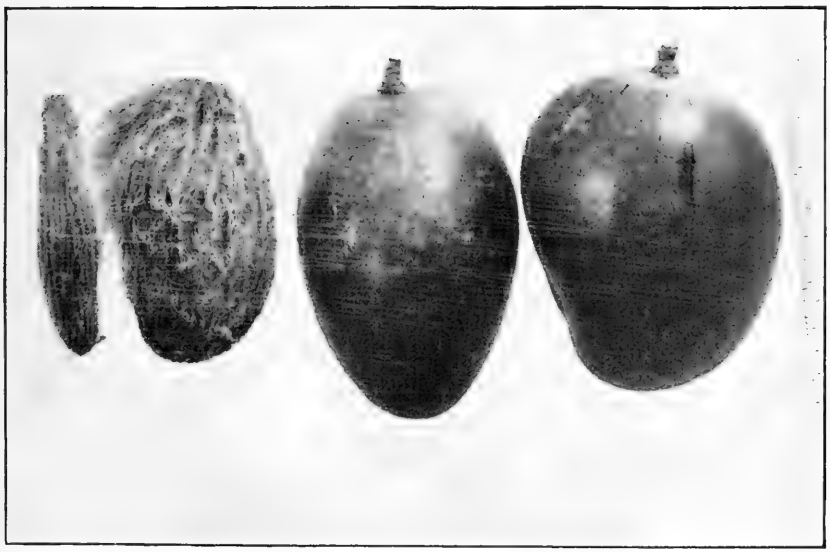

FIG. 2.—DIVINE MANGO.

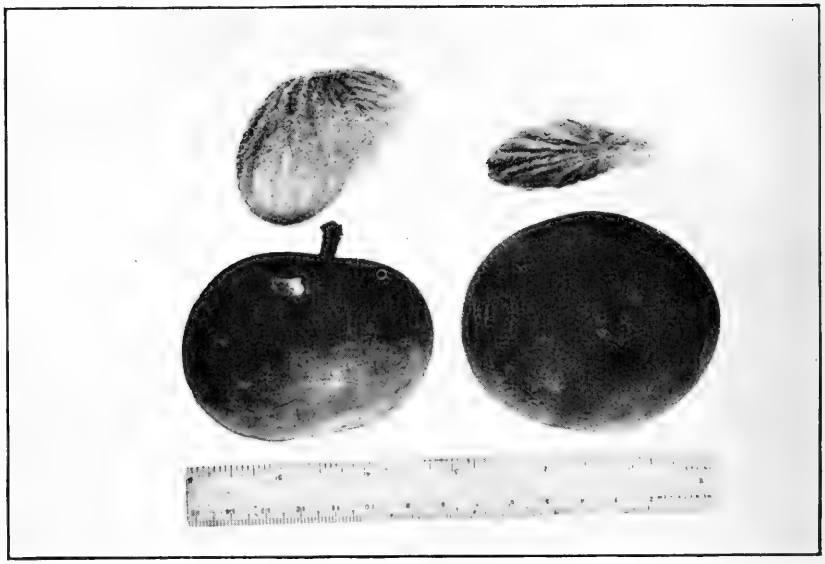

FIG. 1.—ITAMARACÁ MANGO.

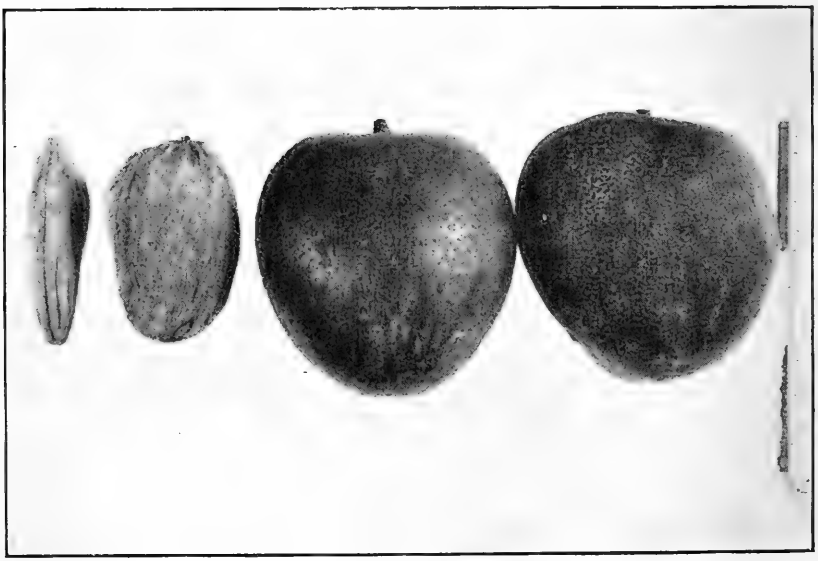

FIG. 2.—MULLGOA MANGO.

is made more prominent by a broad, low ridge extending from near the base to beyond the shoulder, is more prominent than the dorsal. The apex is acute, the beak wanting, and the nak a small russet speck on a low longitudinal ridge ½ inch in length and ¾ inch above the apex. The surface is smooth; the color a rich yellow thinly marbled with green when first ripe and specked and spotted when overripe; the dots numerous and dark russet, varying in size; the bloom white and thin. The skin is thin, weighing about 1 ounce in representative fruits, and rather tender, separating easily from the flesh. The flesh is tender, pale, or deep yellow, depending upon the stage of ripeness and tree variation, lighter near the skin, very juicy, and entirely free from fiber except for a thin strip along the upper ventral side of the seed. The flavor is sweet, aromatic, spicy, smooth, and pleasing. The seed is medium to large in size.

The tree is a vigorous grower, tall and spreading, sometimes conical; the central branches are long, inclined to be slender and flexible and dividing into few terminal branches, leaving the top open. The leaves are a lighter green than in most other varieties and vary greatly in size. Normally they are large and broad, measuring 11 by 2¾ inches. Leaves 20 inches in length are not rare on young, vigorous trees. A pronounced depression follows the veins to near the leaf margin. The leaf terminates in a long acuminate tip.

This variety fruits early and is a regular and prolific bearer. The fruits are free from blemishes, uniformly colored, very attractive, and among the best in flavor and quality. This is one of the most desirable sorts for home use in Porto Rico, but the tender skin may prevent its shipping well. As the fruits are attacked by fruit flies, they must be bagged in seasons when the flies are numerous.

Davy's.[1]—This variety (Pl. VII, fig. 1) has an oval or plump kidney-shaped fruit weighing 8 to 14 ounces; the base and apex are rounded; the surface is smooth; the color dull greenish-yellow until fully ripe and then a dull orange-yellow without blush; the dots large, numerous, light colored, sometimes having black centers; the skin thick and very tough; the flesh very rich orange in color and rather dry, especially near the skin; the fiber not objectionable, although a heavy coat ⅜ inch long covers the seed. The flavor is subacid and, although never rich, is pleasant when the fruit is entirely ripe. The appearance of the fruit and the quality of the skin and flesh are well suited for commercial use, but the trees have not been prolific, individuals 9 years old having borne only a few fruits each.

[1] S. P. I. No. 9522. From Saharanpur, united provinces of Agra and Oudh, India. U. S. Dept. Agr., Bur. Plant Indus. Bul. 66 (1905), p. 285.

The tree is easily identified by its low, regular, spreading, dome-shaped form and its very dense growth of small rich green leaves, about 8 inches long by $1\frac{3}{4}$ inches wide, which are smooth, flat, and lanceolate in form.

Divine.[1]—The general form of the fruit of Divine (Pl. VII, fig. 2) is ovoid, with a broad ridge extending along the lower two-thirds of the ventral side and terminating at the nak in a wedge shape. The typical fruit is uniform in size and shape, being 8 ounces in weight, $3\frac{1}{2}$ inches long, $2\frac{7}{8}$ inches wide, and $2\frac{1}{2}$ inches thick. The stem is medium in length, slender, and obliquely inserted; the base rounded; the ventral shoulder slightly more prominent than the dorsal; the cavity narrow and furrowed; the apex rounded and inclined to be hooked at the nak; the nak slightly depressed and situated $\frac{5}{8}$ inch above the apex and 1 inch from the longitudinal center. The greater part of the surface is roughened by numerous large, irrupted, russet spots; the color is greenish yellow with a dull red blush covering the base; the dots light, numerous, and very small, many having russet centers; the bloom wanting; the skin thick, weighing $1\frac{7}{8}$ ounces, but not tough, separating easily from the fruit with a very thin layer of flesh clinging to it when removed. The flesh is a golden yellow when fully ripe, soft, characterless, juicy, and practically free from fiber (that which is present being short and coarse); the flavor sweet and rich, but strong and unpleasing to some individuals; the seed medium sized, oval, and flat.

The tree makes a slow growth and is open, spreading, usually round-topped and irregular in shape, producing a lighter crop of leaves than most varieties. The leaves, which measure 9 by $1\frac{3}{4}$ inches, are narrow, flat, and tough, with obtuse tips.

This variety is an early, regular, and rather prolific bearer, with fruits free from attacks of the fruit fly, but too small and unattractive for commercial use. The flavor and texture of the fruit make it a second choice for home planting.

Itamaracá.[2]—The fruit of this variety (Pl. VIII, fig. 1) is flattened with a short longitudinal axis, the weight usually ranging from 6 to 7 ounces. A $6\frac{1}{2}$-ounce fruit is $2\frac{3}{8}$ inches from base to apex, $3\frac{1}{8}$ inches wide, and $2\frac{5}{8}$ inches thick; the base is rounded; the shoulders prominent, the ventral shoulder being divided by a broad shallow suture; the cavity deep, broad, and obtuse; the surface smooth, greenish yellow, with a thin, dark red blush at the base; the dots small, white, and numerous; the skin moderately thick and rather tough, separating easily and freely from the flesh. The

[1] S. P. I. No. 21516. From Port of Spain, Trinidad. U. S. Dept. Agr., Bur. Plant Indus. Bul. 132 (1908), p. 161.

[2] S. P. I. No. 23426. From Rio de Janeiro, Brazil. U. S. Dept. Agr., Bur. Plant Indus. Bul. 148 (1909), p. 14.

flesh is juicy and rich yellow in color, with little fiber except a large tuft on the ventral margin of the seed. The flavor is subacid spicy, and aromatic, but not so pleasant as that of many other varieties.

The tree comes into bearing quite early and is very productive. Its season is late, the fruit ripening from August 5 to September 10 in normal years. The good quality of its fruit, its prolificacy, and its late ripening season make this a desirable variety for home use, but it is too small to be suited to present marketing conditions.

Mullgoa.[1]—The Mullgoa (Pl. VIII, fig. 2) is generally rounded in form and large in size, a typical fruit weighing 22 ounces and measuring $4\frac{1}{4}$ by $4\frac{1}{4}$ by $4\frac{1}{8}$ inches. The stem is long, stout, and squarely inserted; the base broad and flattened, sometimes having a shallow, broad cavity; the ventral shoulder slightly prominent and divided by a broad distinct suture; the apex rounded; the nak small and often prominent; the surface dark greenish-yellow, spotted, and roughened by nettings of dark russet which extend over the basal half of the fruit and give it the appearance of old leather. The skin is thick but not tough, and when it is torn off, an equal thickness of flesh clings to it; the flesh is tender and very juicy, greenish-yellow near the skin and light yellow near the seed; a very short fiber covers the seed; the seed is small with very thick, tough husk; the flavor is subacid, rich but somewhat strong, and not so pleasant as that of a number of other varieties.

The tree makes a moderately slow growth and has an open, spreading top, the main branches being few and irregular in growth, with numerous slender, flexible terminal branches which produce only a small crop of small, slender leaves. The trees come into bearing early and they are regular but not prolific bearers. The fruit ripens at Mayaguez late in August and early in September, thus maturing later than any variety tested except Sufaida.

This variety must not be confused with Mulgoba, as in both appearance and quality it is very distinct and somewhat inferior to it.

Sandersha.[2]—This variety (Pl. IX, fig. 1) has a long fruit, the upper half tapering toward the stem, especially on the dorsal side, where the shoulder is often wanting; the plump lower part terminates in a prominent beak. The weight is 1, 2, and occasionally 3 pounds, with an average of 18 to 24 ounces, a 20-ounce fruit measuring 6 by $3\frac{5}{8}$ by $3\frac{3}{8}$ inches. The cavity is wanting; the apex rounded with a prominent beak three-fourths to 1 inch from the longitudinal apex; the nak a small russet speck at the prominent beak; the surface smooth, light yellow in color, with a thin, dull pink blush in the sun;

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[1] S. P. I. No. 7102. From Bangalore, India. U. S. Dept. Agr., Bur. Plant Indus. Bul. 66 (1905), p. 131.

[2] S. P. I. No. 7108. From Bangalore, India. U. S. Dept. Agr., Bur. Plant Indus. Bul. 66 (1905), p. 131.

the dots numerous, small, and whitish, a small percentage of them russeted in the center; the bloom thin and white; the skin fairly thick but not tough, separating easily from the flesh; the flesh light yellow until very ripe, when it becomes reddish-yellow, especially in the interior, moderately juicy, elastic rather than melting in texture; fiber almost wanting; the aroma strong and unpleasant; the flavor subacid, sprightly, strong, but not so rich or pleasing as that of some other varieties. The quality of the fruit makes it suitable for chutney and pickles. If taken from the tree just before or when first starting to soften and allowed to ripen slowly in a cool, airy place, the fruits develop an attractive appearance and pleasant flavor. The seed husk is long, slender, and flat, with a medium-sized kernel in the central part of the husk, leaving both ends flat and thin.

The trees are flat-topped, spreading, and open, with the lateral branches often bending downward. The heavy loads of fruit have considerable influence on the shape. The leaves are large, broad (11 by 3 inches), flat, smooth, tough, and rather thick, with veins prominent on the upper as well as on the lower surface. This variety fruits when 3 or 4 years old and is the most regular and prolific bearer that has fruited at this station. It ripens later than any other variety except Sufaida and Mullgoa.

Sans Pareille.[1]—This variety is rounded at the base with the sides tapering toward a blunt wedge-shaped apex. A good fruit weighs from 14 to 16 ounces, a 15-ounce fruit measuring 4⅛ inches long, 3½ inches wide, and 3¼ inches thick. The cavity is very narrow and shallow; the apex oval with a broad, nearly indistinct beak; the surface smooth and dull yellowish-bronze, with much of the green color remaining in the skin until the fruit is fully ripe; the skin very thin and of average toughness; the flesh abundant, rich orange at the apex, yellow at the base, tender and tenacious rather than brittle, very juicy, especially near the seed; the flavor rich and sweet but strong and unpleasant; fiber absent except for a small area on the seed margin; the seed small and thin, with a thin, easily torn seed coat.

This variety blossoms very early, matures slowly, and ripens from June to July. The tree is prolific but not vigorous and has been the slowest grower among the many kinds tested here, reaching only 8 feet in height at 7 years of age. It has slender branches, with small, slender leaves. Sans Pareille can not be recommended for planting in Porto Rico.

Martinique.[1]—This variety (Pl. IX, fig. 2) resembles Sans Pareille very closely in all particulars, except that the sides of the fruits are more flattened and there is usually a broader, more prominent beak divided by a shallow, V-shaped depression. The trees are prolific,

[1] From Martinique, West Indies.

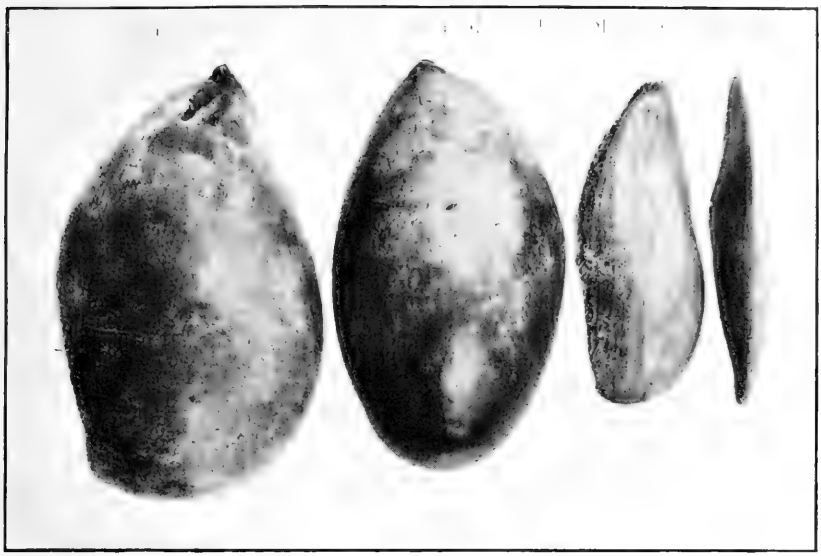

FIG. 1.—SANDERSHA MANGO.

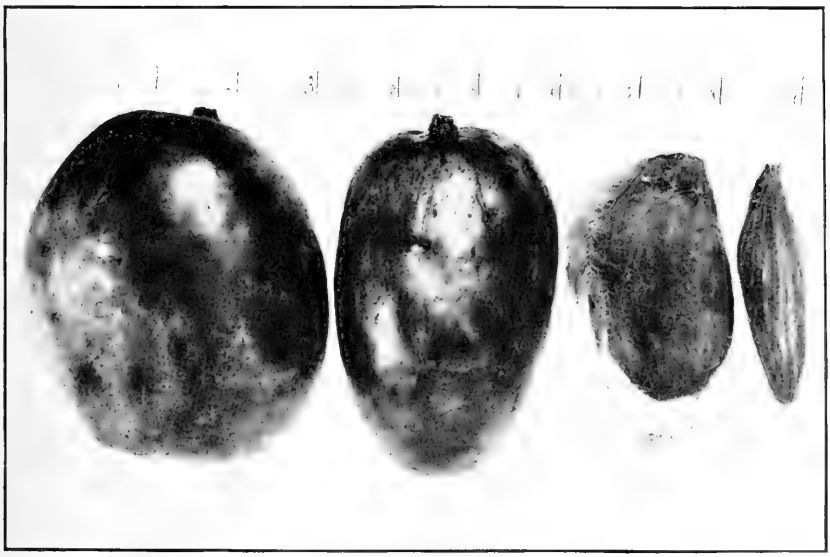

FIG. 2.—MARTINIQUE MANGO.

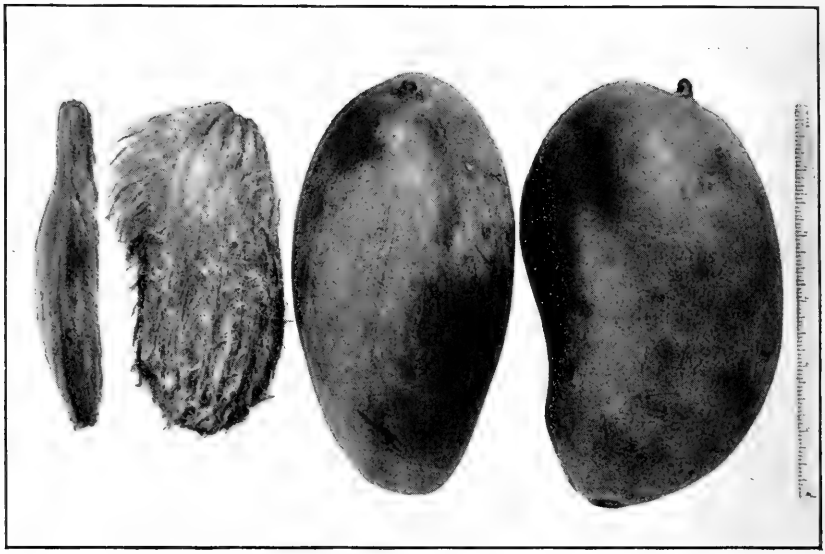

FIG. 1.—SUFAIDA MANGO.

FIG. 2.—TOTAFARI MANGO.

but make a slow and unsatisfactory growth. The fruit is very inferior in flavor.

Sufaida.[1]—The fruit of this variety (Pl. X, fig. 1) is kidney shaped, the longitudinal cross section oval, the lateral cross section usually oval, although the fruit is sometimes flattened at the sides; the size is large, with a range of 24 to 36 and occasionally 40 ounces, a 26-ounce fruit measuring $6\frac{1}{8}$ inches long, $4\frac{3}{4}$ inches wide, and $3\frac{1}{2}$ inches thick; the stem long and obliquely inserted; the base rounded; the ventral shoulder narrow and very prominent; the cavity shallow when present; the apex narrow, rounded, or pointed and beaked; the nak very small, situated $\frac{3}{4}$ to $1\frac{1}{4}$ inches above the apex; the surface smooth, greenish-yellow, never blushed, faintly marked below the epidermis, with thin green, branching, almost transparent nettings that become shorter and finer near the apex; the dots numerous, medium sized, round, and light, with light russet centers; the bloom heavy, white, and not easily removed; the skin very thin, easily torn, but separating easily from the flesh; the flesh dark yellow or orange near the apex, becoming lighter yellow near the seed and toward the base; the flesh of good quality and medium juiciness; the fiber scarce, short, stiff, and coarse; the flavor sweet, refreshing, pleasant, and fairly rich.

The tree is a vigorous grower, with a large oval or dome-shaped top and very regular and dense foliage. The leaves are large, broad (11 by $3\frac{3}{8}$ inches), rather thin, and flexible, with deep furrows following the veins to near the leaf margin.

This variety has been a regular but not prolific bearer. The fruits often crack open before they are ripe—a trouble most prevalent when the tree has a very light crop. Ripening from August 20 until late in September, this variety has a later fruiting season than any other tested in Porto Rico.

Totafari.[2]—In form the fruit of this variety (Pl. X, fig. 2) is oval, except for a large rounded beak and depressions in the lower ventral side extending to the beak; the size usually large, though varying considerably with the size of the crop, the normal weight being from 12 to 18 ounces, a fruit of 14 ounces measuring $4\frac{1}{2}$ by $3\frac{3}{8}$ by $2\frac{7}{8}$ inches; the base rounded; the cavity flat or ridged, with low, broad ridges about 1 inch wide; the apex a rounded oval with a prominent, rounded beak; the nak very prominent, $\frac{1}{2}$ inch above the apex and 1 inch to the ventral side of the vertical center; the surface very smooth, light yellow in color, and, until fully ripe, very light yellow striped and mottled with green, developing, when exposed to the sun, an uneven bright pink blush which is very attractive; the dots

[1] S. P. I. No. 9516. From Saharanpur, united provinces of Agra and Oudh, India. U. S. Dept. Agr., Bur. Plant Indus. Bul. 66 (1905), p. 285.

[2] S. P. I. No. 8732. From Bombay, India. U. S. Dept. Agr., Bur. Plant Indus. Bul. 66 (1905), p. 219.

large, numerous, black on the upper half of the fruit but small and light near the apex; the skin thick, tough, and easily removed with a layer of flesh clinging to it; the flesh a bright yellow, very juicy, and without fiber, except for a thin strip on the ventral margin of the seed; the flavor subacid, spicy, and very agreeable.

The tree is a vigorous grower, open and spreading in habit. It comes into bearing at two or three years after grafting, and is a regular and prolific bearer, the fruit of an individual tree being uniform in size for a given crop. The fruits are sometimes attacked by fruit flies, though seldom seriously. They keep well after picking, and are attractive and suitable for both home and market use.

PORTO RICAN TYPES.

In different sections of Porto Rico the same type of native mango is frequently known under several names, while just as frequently various types are given the same name. In spite of the resulting confusion and duplication of terms, it has been found that the most important native sorts do not grow in all sections but are for the most part confined to comparatively small areas, probably because of climatic conditions. In these given areas practically all trees of a certain type, although seedlings, produce remarkably uniform fruit, often as much so as that of grafted trees. Their fruit is frequently inferior to imported varieties, although most of them produce plants which are very satisfactory for stocks. The following are descriptions of the most desirable kinds and those most commonly found for sale at markets:

Blanco.—This is a type (Pl. XI, fig. 1) found most commonly in the western part of the island, practically all of the mango trees in some localities belonging to it (Pl. I, fig. 2). The most prolific and popular of the Porto Rican mangoes, it is the principal one used for shipment to the different towns of the island. The fruit is oval and plump, with a narrow, flattened cavity and broad, low, V-shaped beak. The skin, smooth, tough, and light yellow in color, adheres to the flesh; the flesh is yellow and juicy, comprising only two-thirds of the total weight of the fruit and having a sweet, pleasing flavor, not strong with turpentine but without richness. The seed is large and the fiber long, coarse, and plentiful. An average fruit weighs about 7 ounces and measures $3\frac{1}{4}$ inches long, $2\frac{3}{4}$ inches wide, and $2\frac{1}{2}$ inches thick.

Mangotina.—This kind (Pl. XI, fig. 1) is found most commonly near Ponce. The fruit is rounded and plump, weighing about $5\frac{1}{2}$ ounces and measuring $2\frac{7}{8}$ inches long by $2\frac{1}{4}$ inches wide. It resembles Blanco, but differs in being blushed over a broader area. The skin is thin, the fiber long and plentiful, and the flavor of second quality among Porto Rican mangoes.

Redondo.—This fruit (Pl. XI, fig. 1) weighs about 7 ounces and is $3\frac{1}{4}$ inches long and $2\frac{7}{8}$ inches broad. A heavy, attractive, dark-red blush covers one side, and the dark-red color extends thinly over the yellowish-green ground color on the opposite side. The flesh is tender and juicy, the fiber long and abundant, the flavor pleasant, but lacking in richness and quality.

Largo.—This type, which is very common in the southwestern part of the island, has a small oval fruit (Pl. XI, fig. 1), weighing about 5 ounces, with a thin tough skin separating easily from the meat. It is an unattractive fruit, the color being green blotched with dull yellow, the flavor sweet, but decidedly like turpentine, and the fiber long, coarse, and abundant.

Piña.—The most common of the types known by this name (Pl. XI, fig. 2) is found on the western part of the island. The fruit is long, plump, and tapering toward the base. It is about 5 inches long by 3 inches wide and distinctly beaked. The dull-yellow, unblushed skin is smooth and separates easily from the flesh. The flesh, a rich yellow in color, lacks juiciness and has an abundance of coarse fiber. The flavor is sweet but not rich.

WEIGHTS OF DIFFERENT PARTS OF FRUITS OF IMPORTED AND NATIVE TYPES OF MANGOES.

The table given below shows the weight of the different parts of normal fruits of a number of imported and native mangoes produced in Porto Rico. All of the imported varieties are from the Orient, except Divine from Trinidad, Sans Pareille from Martinique, and Itamaracá from South America.

Weight of different parts and percentage of edible portion of fruits of imported and native types of mangoes.

	Weight of whole fruit.	Weight of skin.	Weight of seed.	Weight of flesh.	Amount of flesh in whole fruit.
Imported varieties:	*Ounces.*	*Ounces.*	*Ounces.*	*Ounces.*	*Per cent.*
Amini	8	$1\frac{1}{4}$	$1\frac{1}{8}$	$5\frac{5}{8}$	70
Bennett	13	$1\frac{7}{8}$	$1\frac{1}{4}$	$9\frac{7}{8}$	76
Cambodiana	10	$1\frac{1}{8}$	$1\frac{1}{2}$	$7\frac{3}{8}$	74
Mullgoa	22	$3\frac{3}{8}$	$1\frac{3}{4}$	$16\frac{7}{8}$	77
Sandersha	20	3	2	15	75
Sufaida	26	$2\frac{1}{8}$	$2\frac{1}{4}$	$21\frac{5}{8}$	83
Totafari	14	$1\frac{5}{8}$	$1\frac{3}{8}$	11	79
Divine	8	$1\frac{1}{2}$	1	$5\frac{1}{2}$	69
Sans Pareille	15	$1\frac{1}{2}$	$1\frac{1}{8}$	$12\frac{3}{8}$	83
Itamaracá	$6\frac{1}{2}$	$1\frac{5}{8}$	1	$4\frac{1}{8}$	63
Porto Rican kinds:					
Blanco	7	$1\frac{5}{8}$	$1\frac{1}{8}$	$4\frac{1}{2}$	61
Mangotina	$5\frac{1}{2}$	$1\frac{1}{8}$	1	$3\frac{3}{8}$	61
Redondo	7	$1\frac{1}{8}$	$1\frac{1}{4}$	$4\frac{5}{8}$	66
Largo	$5\frac{1}{4}$	1	$1\frac{3}{8}$	$2\frac{7}{8}$	55

PROTECTION AGAINST FRUIT FLIES.

A fruit fly (*Anastrepha fraterculus*)[1] is very common in Porto Rico and very injurious to fruits of some varieties of both wild and imported mangoes. As it breeds in other wild fruits, some of which bear throughout the year, it would be very difficult to eradicate or control. As the fly seldom attacks the fruit before it commences to ripen, injury can be easily and cheaply prevented by bagging the fruit with paper just after it has attained full size but before it has started to soften. The cheapest quality of bags may be used, several hundred of which can be placed by one person in a day. A small hole should be made in the bottom of the bag to allow water entering on the fruit stem to drain out, as this will otherwise collect and burst the bag. While the paper covering hinders to some extent the development of the red blush on varieties normally blushed, it protects the bloom, prevents sunburn, and gives a more even and delicate blush, all of which adds to the attractiveness of the fruit. The imported varieties most commonly attacked by the fruit fly are Cambodiana, Totafari, and Sandersha, although in some years the injury is not serious enough to necessitate protection.

Except for thrips, which are very detrimental to young pot and nursery trees, the fruit fly is the only insect pest of the mango which has thus far been of importance in Porto Rico.

HARVESTING AND PACKING.

As the mango is edible during only a rather short period and is easily bruised, it is important that no fruit should be packed for shipment or stored with the expectation of its remaining long in good condition if it has been bruised or injured in any way. If properly taken from the tree, placed in a crate cushioned with some suitable material, such as excelsior, and not allowed to be bruised by the weight of other fruit the mango may be expected to remain sound for a reasonably long period.

REMOVING THE FRUIT FROM THE TREE.

In harvesting fruit which is not fully ripe, a stem slightly longer than the fruit stalk should be left, as the high pressure generated in the fruit while on the tree will force a spray of juice through the large cells of the fruit stalk the instant it is severed, a jet of juice sometimes being thrown several feet from the fruit and continuing to flow for a few seconds. After curing a few minutes the large cells of the fruit stalk are emptied and form open passages into the base of the fruit, where decay soon starts.

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[1] Porto Rico Sta. Rpt. 1912, p. 36.

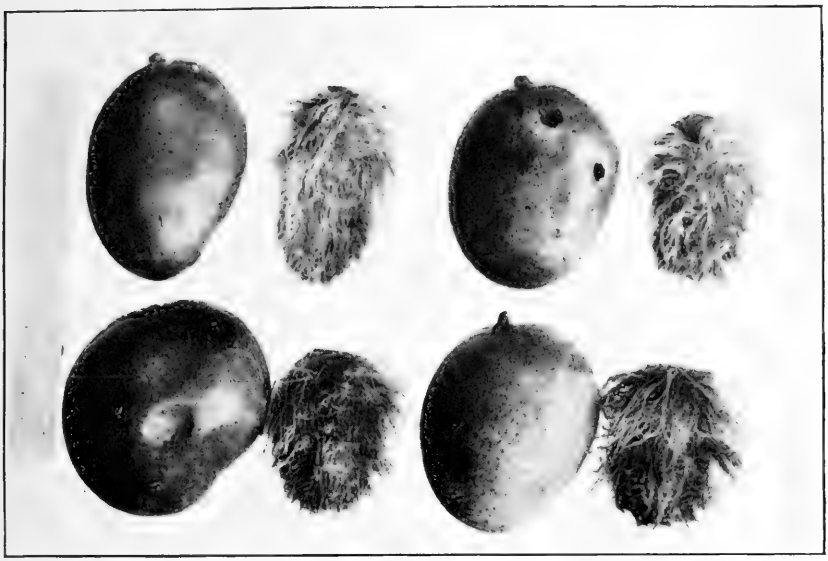

FIG. 1.—UPPER, LEFT TO RIGHT, LARGO, MANGOTINA; LOWER, REDONDO FROM PONCE, AND BLANCO.

FIG. 2.—UPPER, LEFT TO RIGHT, REDONDO FROM AÑASCO, AND TORO; LOWER, PIÑA FROM MAYAGUEZ, AND PIÑA FROM AÑASCO.

TYPES OF PORTO RICAN MANGOES.

To test the effect of cutting the stems too short when harvesting, two lots of 100 fruits each, which had colored but had not started to soften, were taken from the tree, wrapped in newspaper, and stored at a temperature ranging from 80 to 83° F. Long stems were left on one lot while the fruit stalks of the other were cut near the fruits. Six days later an examination showed that 12 of the fruits with long and 61 with short stems were decaying. The bending of the long stems in handling probably caused injury, as a number of the decaying specimens were affected at the base. A large percentage of the fruits had small discolored skin spots at the time of examination, which is characteristic of this and other native types of mangoes a few days after harvest. When fruits are allowed to ripen on the tree the internal pressure is so reduced as to make the length of the stem unimportant.

WRAPPING FRUIT FOR STORING.

To determine the value of a few common materials for use in wrapping fruits for storage, lots of 100 fruits of the common variety Blanco were wrapped in each of the following materials: Orange wrapping paper, newspaper, oil paper, and coconut fiber. One lot of fruit was exposed to the open air as a check. The fruits were two-thirds colored when harvested and would have begun to soften in a very few days if they had been left on the tree.

Results of tests with different wrapping materials.

Wrapping materials.	Eighth day.			Eleventh day.	
	Number of fruits partly green.	Number of fruits yellow.	Number of fruits decaying.	Number of fruits yellow.	Number of fruits decaying.
Orange wrapping paper	53	36	11	48	52
Newspaper	39	47	14	38	62
Oil paper	37	56	13	31	69
Coconut fiber	32	57	21	22	78
Check	46	38	16	34	66

The above table shows that the fruit in the orange wraps ripened more slowly and remained in good condition longer than the other lots and that the fruit packed in coconut fiber ripened more quickly and decayed earlier than the other lots. There was no marked effect of the other materials on the keeping qualities of the fruit.

MANGO STORAGE.

From observations on the few imported mangoes which have fruited in Porto Rico, it appears that the flavor and keeping qualities of different varieties depend very much upon the stage of ripe-

ness at which the fruit was removed from the tree, and careful tests should therefore be made to determine the proper degree of maturity for harvesting fruit of each individual variety which will suit it to the use for which it is intended. For eating fresh, the fruit of all varieties, with the possible exception of Sandersha, should be allowed to color fully and to begin softening on the tree, while fruit for marketing should be taken from the tree at the stage of maturity at which it will resist decay longest—that is, before it is fully colored or has begun to soften, the fruit of most varieties having sufficient merit to warrant its sale at satisfactory prices if so harvested. With the varieties Amini, Divine, Sans Pareille, and possibly others, the fruits develop too strong a flavor to be palatable if left to ripen fully on the tree.

STORAGE TESTS.

The following summary of results from storage tests of a number of varieties indicates the proper time for harvesting where a long or short period is to elapse before the fruit is to be consumed. In these tests long stems were left on the fruits and all were wrapped in paper. Where sufficient fruit was available, the tests were made in both warm and cold rooms. In the warm storage room, a temperature of 80° to 83° F. was maintained, and in the cold room, which is an ice storage room, the temperature varied from 40° to 47°.

Amini.—Two lots of this variety were placed in the warm room, one of 50 fruits taken from the tree in edible condition, the other of 50 fruits of mature size and light yellow color, all of the green having disappeared from the skin, but which had not started to soften on the tree. In four days 5 of the first lot showed decayed spots, and in six days 14 were affected, the other specimens having somewhat lost their characteristic flavor. Of the second lot, one fruit showed decay on the seventh day after storing and 11 were slightly discolored by the tenth day. All specimens of this variety developed a very attractive color in storage.

Two lots of this variety, in the same condition as those tested in the warm room, were placed in the cold room also. Eleven days after storing small decaying spots appeared on a few of the specimens which were ripe when harvested, but the flesh was palatable, the flavor and texture having undergone no perceptible deterioration. A few of these specimens were still in good condition 18 days after storing, but the skins of most of them had become discolored. The fruits harvested just before they had started to soften developed a rich yellow color in 10 days, but were still firm. They were ripe 10 days later and remained palatable for 6 days. Full-sized fruits picked just as they started to color remained apparently unchanged in the cold room for four weeks, the flesh then slowly

softening, but decay spotted the skins and their color and flavor were unsatisfactory for market.

Cambodiana.—Twenty fruits which had ripened and fallen into bags attached to the branches were stored in the warm room and in five days three were showing decay and the flesh of others was soft and watery but of fair flavor. Of 20 fruits harvested when over half the surface was soft, all were fully ripe in six days, 3 having started to discolor, while on the eighth day many were still in good condition with flavor and color not inferior to fruits ripened on the tree. Another lot of 20 fruits harvested when about half colored but still firm and placed in the warm storage room, remained in good condition for eight days, except two fruits which decayed apparently from bruises. On the tenth day the remaining specimens were in good edible condition and their smooth, spotless, yellow skins and rich yellow flesh made them especially attractive.

In the cold room, fruits which had become entirely ripe on the tree were too soft and watery in 6 days to be considered first class, while all those which had colored but had not started to soften on the tree had developed a typical ripe color and were of good edible quality 19 days after storing, but by the twenty-sixth day darkened areas were appearing on the skin and outer flesh and the flavor had somewhat deteriorated. Full-grown specimens which had just started to color on the tree became whitish-yellow in 16 days and softened in 26 days, but they were inferior in flavor and color to those that had colored on the tree.

Totafari.—Thirty fruits of this variety, harvested when of mature size and three-fourths colored but not yet starting to soften, were stored in the warm room. All were of excellent marketable color and quality eight days later, except four specimens which became discolored in four days possibly from small breaks in the skins due to handling. Fifty full-sized fruits harvested when first showing maturity in color ripened and remained in excellent condition for 12 days. On the fifteenth day 16 were slightly discolored, and the flesh of others was watery and less palatable than when first ripe.

In the cold room 19 out of 20 fruits of this variety which had ripened on the tree were unblemished by decay 14 days after storing. Other specimens picked when all the green color in the skin had disappeared, but several days before they would have begun to soften, remained apparently unchanged for 14 days. No decay was observed until the twenty-fourth day after harvesting, at which time and for nearly two weeks later the fruits were little inferior in color and flavor to tree-ripened specimens.

Sandersha.—Of 50 well-colored specimens harvested just before they started to soften and placed in the warm room, all but eight were free from decay and in condition for eating nine days later,

remaining so for three days. A duplicate lot of fruit in the cold room developed a good flavor and remained in good physical condition for nearly five weeks. The flavor and appearance of these fruits were better than that of tree-ripened specimens. Full-sized fruit which had not started to color on the tree turned a light yellow and softened within 12 days after being placed in the warm room, but they did not develop a pleasant flavor. Those of the same age remained apparently unchanged for over two months in the cold room, finally developing dark, softened spots in the skins, although the flesh was still hard and brittle. Fruits which had become soft on the tree lost none of their flavor after remaining in the cold room for 15 days, although by this time dark spots were appearing on the skins.

Divine.—Forty of the 50 specimens of Divine, which were harvested when they first began to soften and left in common storage, were still in edible condition six days later, although a number of them had developed dark spots in the skins and were not attractive.

Bennett.—Specimens of Bennett harvested when mellow on one side and three-fourths colored, still had an excellent flavor and had just started to discolor after seven days in the warm room, while fruits taken from the tree when half colored and ready to soften developed an excellent color and flavor and showed no decay after eight days, retaining their good flavor a few days longer.

Blanco.—Two lots of this variety, which is the most plentiful and most desirable of the wild Porto Rican kinds, were tested at the high and the low temperatures. In the warm room colored fruits which had not started to soften when taken from the tree were ripe in four days. Two days later 40 per cent of the lot were blemished by decay, and the flesh was soft and watery. In the cold room the fruits became spotted with decay in seven days, before they were ripe enough for eating. Tree-ripened fruit started to decay on the fifth day in the cold room and were badly decayed in four days at the higher temperature.

The very poor keeping quality of this variety is typical of all the common Porto Rican varieties. Although the fruits were carefully selected and packed, dark spots appeared in the skins in a very few days and rendered the fruits unsatisfactory for market.

MANGOES AS ORNAMENTALS.

The mango is doubtless the most beautiful and generally satisfactory of trees for beautifying land spaces and for general ornamental planting in Porto Rico. Of large size, symmetrical shape, and hardy, thrifty growth, they are dependable in all seasons, and the new leaves with their changing shades, appearing at intervals throughout the year, are more attractive and more desirable for

ornamental use than the blossoms of most other trees in Porto Rico. Fortunately, the imported varieties which produce fruit of high quality are most desirable as ornamentals, as there is a great variation in the habits of growth and color of the foliage among them. For avenues and boundaries any of the large growing, vigorous kinds are satisfactory, but for planting singly on lawns or in parks varieties suited to the peculiar needs should be selected. For the latter purpose Cambodiana, a tall, open tree, with large, light-green leaves tinged with yellow; Davy's, a low, compact tree with medium-sized leaves of dark-green color; Madras, a very graceful, symmetrical, upright tree with small bluish-green leaves; and Peters, a round-topped, dense-growing tree with large, very dark-green leaves, are among the varieties which should receive first consideration.

SUMMARY.

The common mango of Porto Rico, which is one of the most important fruits of the island, is not cultivated but grows wild in all localities. Superior varieties lately imported have proved satisfactory and should be planted extensively for market and home use.

Mango trees are adapted to a wide range of soil types and will grow satisfactorily in practically all Porto Rican soils, provided there is a good subdrainage.

While the climate throughout the island is suitable for the growth of mango trees, in some localities, notably through the interior and along the northern slopes, rains are sometimes too frequent during the blossoming season to permit the setting of a good crop of fruit. Along the western and northern lowlands rainfall is light during the blossoming season and good crops are almost invariably secured.

As the prevailing winds and morning sun seem to be very beneficial, both for growth of trees and setting of fruit, open, exposed sites should be selected for the mango orchard.

Inarching and bark grafting, simple methods for asexual propagation, are satisfactory both for use in the nursery and for top-working large trees. The important conditions in grafting are that the stock be just starting a new growth, the scion mature, and the buds ready or almost ready to open.

Large seeds which produce only one plant are most satisfactory for stocks. The East Indian varieties produce larger and more thrifty plants, as a rule, than the native kinds. Both nursery and other mango trees may be transplanted successfully if they are not making a new growth and rainfall is plentiful.

The present confusion in the classification of types of mangoes, as well as the great variation in growth and productiveness of trees, and quality of fruit, necessitates a thorough study of varieties before a mango orchard can be successfully planted in Porto Rico.

Among a number of imported varieties that have fruited here, the most productive of the thrifty kinds with fruits of high quality are Cambodiana, Totafari, Amini, Bennett, and Paheri. Cambodiana and Paheri are probably better suited to home than to commercial use.

The trees of the few varieties from Martinique, Trinidad, and South America thus far tested lack vigor, while the fruits are either inferior in quality or too small to be promising for general planting. As regards size, flavor, fiber content, and keeping quality, the wild Porto Rican mangoes are less desirable than many imported kinds.

In harvesting mangoes that have not softened on the tree, a stem longer than the fruit stalk should be left to prevent the juice from the base of the fruit from escaping through the fruit stalk and leaving passages for the entrance of infection.

Fruits in orange wrapping paper did not ripen or decay so quickly as those wrapped in oil paper, newspaper, or coconut fiber, or those left in the open air. Fruits packed in coconut fiber ripened earliest.

East Indian varieties showed much better keeping qualities than the native kinds.

The mango is one of the most satisfactory ornamental trees for Porto Rico, as variations in habit of growth and color of foliage make it possible to select from varieties producing fruit of high quality those which best carry out a particular scheme of landscape gardening.

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