California Avocado Association Annual Report 1921-1922 7: 65-78

Investigations in Avocado Breeding

B. S. Nirody, B.A., F.R.H.S.

Part of Thesis submitted for the Degree of Master of Science, Massachusetts Agricultural College, April, 1922,

Introductory

It is now generally known that the culture of the avocado (*Persea americana* Mill) already bids fair to rival the citrus industry in Florida, and that a similar outlook is described by the growers of California. The annual reports of the Florida State Horticultural Society and of the California Avocado Association, in successive years, make it abundantly clear that the avocado has already established its position as a standard fruit of commercial importance. Wilson Popenoe, who has made an extensive study of the fruit in all those countries where it has been grown since early times—the West Indies, Mexico, Guatemala, Costa Rica and Northern South America—and who is our best authority on this subject, is convinced that the avocado will before long be as familiar to the American people as the banana is today. (For an analysis of the fruit indicating its high food value, see Appendix.)

While the incredible prices which the fruit commands today, because of the inadequate supply, make it one of the most profitable branches of subtropical orcharding, growers both in California and Florida agree that from a strictly commercial point of view it is necessary to stabilize the industry by establishing standard varieties of the fruit which best meet the requirements of the growers as well as of the market. This is voiced most emphatically by the owners of avocado orchards at their annual conventions year after year. In other words, the avocado industry is now in the same stage of development as the citrus industry of a few years ago. In citrus fruit culture commercial planting is confined to one or two standard varieties of the orange, the grapefruit and the lemon. Likewise, in avocado orcharding, from among the countless varieties that are introduced from regions where the fruit is native, the best types that answer the needs of the different climatic conditions of Florida or of California, and the requirements of the northern markets, will have to be evolved by breeding. Once this ideal type is produced, all subsequent propagation can be carried on by asexual methods and the desirable qualities can be perpetuated.

The cultivated avocados fall naturally into three distinct groups or "races": (1) The West Indian, (2) the Guatemalan, and (3) the Mexican. Each of these has important merits as well as defects; these are discussed in detail in another part of this paper. Briefly, the West Indian thrives well in Southern Florida, but not in Northern Florida or in California. The Mexican, on the other hand, is known to grow well in California and certain sections of Northern Florida, but is not well adapted to conditions in Southern Florida. The

Guatemalan has qualities which make it of great value both in Florida and in California. But even the best existing varieties of the Guatemalan group have defects which the grower would like to eliminate. Hence the necessity of breeding, so as to combine the qualities of the best Guatemalan and Mexican varieties for the California orchards and the best Guatemalan and West Indian for those of Florida.

The present investigation was undertaken under Florida conditions.

For the facilities provided by an extensive orchard containing several hundred trees of the leading varieties in bearing condition, and also for valuable information regarding the performance of those trees in previous years, the writer is indebted to William J. Krome of Homestead, Florida, Vice-President of the Florida State Horticultural Society.

It is outside the purpose of this investigation to enter into the controversy as to whether the three so-called "races" of the avocado (the West Indian, the Guatemalan, and the Mexican) belong to one species, *Persea gratissima,* Gaertn f. (*P*. *americana,* Mill), or whether the West Indian and the Guatemalan alone comprise the *Persea americana,* and the Mexican group forms a separate and distinct species, which, according to Mez, is *Persea drymifolia* (Cham. & Schlecht). Let us suppose for the time being that all three are one species.

From a horticultural standpoint each of the three "races" has merits as well as demerits, and these may be summarized as follows:

The West Indian Group.

MERITS	DEFECTS
1. Heat resistant. Thrives well in Florida.	1. Susceptible to frost.
2. Named varieties are of good quality.	2. Shipping qualities comparatively poor.
3. Prolific.	3. Seed often loose in the seed cavity.
	4. Matures too early in the season. (The last mentioned defect is considered by far the most important one commercially.)

The Guatemalan Group.

MERITS	DEFECTS
1. Matures, as a rule, in a later season.	1. Susceptible to heat. Tips of the leaves are often scorched by heat in Florida.
2. Resistant to frost.	2. Irregular bearer, often bearing in alternate years.
3. Includes varieties of very good quality and of vigorous growth.	3. Skin usually rough and often warty in appearance.
4. Seed tight in the seed cavity.	

The Mexican Group.

MERITS	DEFECTS
1. Very productive.	1. Fruit usually small, with large seed.
2. Hardy.	2. Shipping qualities poor, flavor.
3. Rich in taste, with a distinct flavor	3. Not well adapted to the lowlands.

It is here pertinent to inquire as to the qualities most desired in a standard avocado from a horticultural standpoint. They are these:

1. The tree must be resistant to frost injury.
2. The tree must be a vigorous grower.
3. It must be a good bearer—i. e., yielding reasonably heavy crops.
4. It must bear regularly—i. e., annually.
5. It must bear when fairly young—i. e., it must not take too long to come into bearing.
6. The fruit must mature in the right season—i. e., from October to the middle of March. This is by far the most important consideration with the growers, since fruit marketed outside this period brings poor prices because of competition with imported fruit in the Northern markets.
7. The fruit should be of medium size.
8. The fruit should be uniform in shape, preferably round instead of elongate or pyriform, to permit of standard packages with a definite number to the crate.
9. It must be disease-resistant. Some varieties are susceptible to scab.
10. The quality of the fruit should be good; in practice this offers no material difficulty, since the varieties already in cultivation are nearly all of good quality and free from fiber.
11. The seed should be tight in the cavity; a loose seed injures the fruit in transit.
12. The size of the seed should be small compared with the size of the fruit. This does not present any difficulty in practice, since in a medium, standard-sized fruit the size of the seed can usually be overlooked unless it is abnormally large.
13. The ripening of the fruit should be even. Some fruit of the Mexican group, cultivated in Florida, is often known to ripen unevenly.
14. The skin should be smooth but hard enough to ship well. Some Guatemalan avocados have a rough, warty and ungainly appearance, while the smooth-skinned West Indian and Mexican fruits do not ship so well.
15. The color of the fruit, under present market requirements, should preferably be green. However, some of the purple Guatemalan varieties are generally associated with excellent quality and flavor. This question of color had, perhaps, be best overlooked at present, because it is not unlikely that at a future date, when public opinion is better informed about the quality of named varieties, the purple-colored fruit may even be preferred to the green.

It will be seen that the choicest of the West Indian, Guatemalan, or Mexican avocados now in the trade, while conforming to the ideal in many important particulars, nevertheless have an outstanding defect or two which the grower feels ought to be

eliminated. These defects are more or less characteristic of the group or "race" to which they belong.

The following is a list of the varieties considered for breeding in the present investigation:

(W. I.)—West Indian. (G.)—Guatemalan. (M.)—Mexican.

1. Collins (G.)
2. Fuerte (Hybrid, G.-M.)
3. Linda (G.)
4. Macdonald (G.)
5. Pollock (W.I.)
6. Puebla (M.) (?)
7. Queen (G.)
8. Sharpless (G.)
9. Taft (G.)
10. Taylor (G.)
11. Trapp (W. I.)
12. Wagner (G.)
13. Waldin (W. I.)

The above list is not in any order of preference, but is only alphabetical. It is possible that in the opinion of individual growers some of the varieties included above may deserve to be replaced by others, which, in their estimation, have better qualities. The present list, however, is based on a consensus of opinion and not on individual likes and dislikes. It must be added that some of the recent seedlings from the Collins, Winslow, and Taylor are considered to hold great promise, though it is obviously too early yet to speak of them as standard varieties. It will be admitted that none of the pure seedlings of the West Indian, Guatemalan, or Mexican avocado can by themselves produce the best varieties commercially, since whatever defects exist are the defects of the group or "race" and are therefore more or less reproduced in the pure line. If cross-breeding is thus indispensable, it must be selective and not left to chance. The varieties so far tested out in Florida may therefore furnish at least a starting point for combining the qualities desired.

The Trapp, Waldin, and Pollock furnish three of the best West Indians, each remarkable for some particular quality—the Trapp for its overabundant crops, the Waldin for lateness of maturity (that is, in its class), and the Pollock for its large size.

The Guatemalan group furnishes varieties which, in addition to their general hardiness and good shipping qualities, include the Collins, Macdonald and Sharpless, noted for their late season of maturing; and the Linda, noted for its size.

Of the Mexican group, the varieties that particularly merit consideration under Florida conditions are the Puebla and the Fuerte, both of which are supposed to be Mexican hybrids; the Fuerte, at least, is certainly of mixed parentage.

(Vide: Popenoe, Wilson, *Manual of Tropical and Subtropical Fruits,* 1920, p. 78, and California Avocado Association, *Circular No. 1,* October 25, 1917; also *Annual Report* of the California Avocado Association, 1919, note on page 74.)

The Knight, which is a Guatemalan and also considered a very desirable variety, deserves a place in the above list. It is omitted, since it was not available for pollination at the time.

The qualities that we seek to counterbalance are these:

FRUIT	CROPS	SKIN
Early vs. late.	Alternate vs. regular.	Rough vs. smooth.
Small vs. large.	Shy vs. prolific.	Tender vs. hard.
Medium rich vs. super-rich.	Tree, slow growing vs. vigorous.	

HARDINESS

West Indian vs. Guatemalan for Southern Florida.
Mexican vs. Guatemalan for Northern Florida and for California.

Some Combinations Attempted, and the Reasons for Them

1.	Collins	+ Pollock	2.	Fuerte	+ Linda + Taft + Queen + Knight
3.	Knight	+ Trapp + Waldin + Fuerte + Puebla	4.	Linda	+ Trapp + Waldin + Puebla + Fuerte
5.	Macdonald	+ Pollock	6.	Pollock	+ Collins + Macdonald + Wagner
7.	Puebla	+ Taylor + Taft + Linda + Queen + Knight	8.	Queen	+ Trapp + Waldin + Puebla + Fuerte
9.	Sharpless	+ Trapp + Waldin	10.	Taft	+ Trapp + Waldin + Puebla + Fuerte + Pollock
11.	Taylor	+ Puebla + Waldin	12.	Trapp	+ Linda + Queen + Knight + Taft
13.	Wagner	+ Pollock	14.	Waldin	+ Linda + Knight + Taft + Queen

Explanatory

It may be well to state at the very outset that the object in making these combinations is

twofold: It is obvious that these crosses cannot be expected to produce, all at once, the ideal fruit. But in the result one of two things must happen: either, in this first generation, as is likely to happen, the hybrid may contain a combination of characters intermediate between the two parents, in which case we shall have combinations which bring us nearer the ideal and which will be satisfactory commercially, at least for the time being; or, the product of these crosses may cause the parent types (which may themselves be heterozygous) to break up into new combinations, in which case we shall have ascertained more definitely the behavior of these varieties in cross-pollination, and also obtained fresh material with which to build up the ideal fruit by a series of further crosses.

The Pollock and the Collins are both very desirable in their respective classes, but yet, they have excellent contrasting qualities. The first, being a West Indian, will tend to be more hardy in union with the Guatemalan. The outstanding defect of the Collins is that it is a trifle too small. It is, however, a prolific variety. The Pollock, on the other hand, is a fruit known for its size, but it is not always a regular bearer. Again, the Pollock shares the defect common to the West Indians in that its season is too early, while the Collins, if anything, is a trifle too late. The Collins is considered exceptionally rich in flavor, while the Pollock would not be the worse for having its flavor somewhat enriched. The Pollock, partaking of the qualities of the harder skin of the Collins, must prove a better shipper, while the shell-like skin of the Collins must improve in appearance when moderated with the smoothness of the West Indian Pollock. It will thus be seen that the Collins and the Pollock make an ideal combination so far as Florida growers are concerned. A hybrid that is fairly intermediate between the two parents would reasonably be expected to bring us nearer the ideal. The Macdonald stands almost precisely in the same line as the Collins in relation to the Pollock.

The Taft, despite the slightly unfavorable reports concerning it by growers too close to the sea, is by general consent regarded as one of the best commercial Guatemalans in Florida. The Waldin is regarded as its counterpart in the West Indian group. These two varieties have many merits in common, and in the slight demerits they supplement each other. The Taft is a fruit medium to late in maturing, while the Waldin is a conspicuously late variety of the West Indian class, which, however, is none too late for market requirements. The Taft may welcome a slight increase in its size, which the Waldin can impart to it. The Waldin might be rendered hardier with the Guatemalan blood in it, while the Taft would have much to gain from the Waldin as a regular and prolific bearer. In regard to the quality of the skin, the benefit is mutual, that of the Waldin being smooth but a somewhat delicate type, while that of the Taft is rough but harder and ships better.

Among the other Guatemalan varieties of especial merit are the Taylor, Queen, Wagner, Knight, Linda, and Sharpless. The performance records of the Knight and Sharpless are as yet incomplete, but so far as is known at present under Florida conditions, they promise a prominent place in commercial planting for these varieties.

The Linda, in particular, is already noted for its vigorous habit, while the fruit is conspicuous for its large size. It is also a late fruit, but the bearing qualities are not quite so uniform as one would wish them to be. The Trapp is regarded as the complement of the Linda among the West Indians, as it is notorious for its over prolific qualities,

irrespective of seasonal conditions. The early maturing quality of the Trapp would be counterbalanced by the late habit of the Linda and a blending of the somewhat rough skin of the Linda with the smoothness of the Trapp would be a welcome feature.

The Wagner is considered an excellent Guatemalan, its only defect being that it is a trifle too small. Crossed with the Pollock, the result may bring us nearer the standard.

* * * *

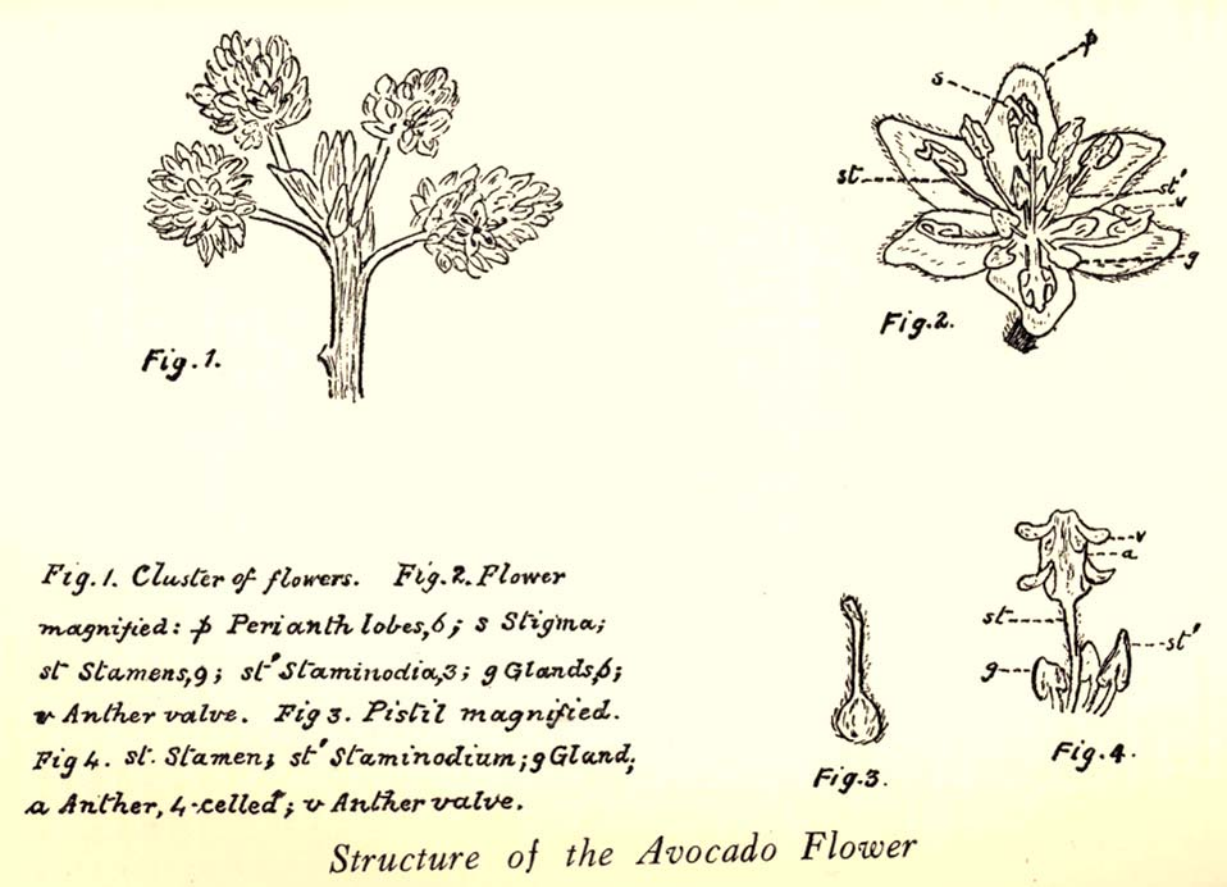
The number of flowers in a panicle varies largely with the variety. Approximately 150 to 500 flowers are borne on the several panicles emerging from each branchlet, and all these can be conveniently enclosed together in fairly large-sized manila bags (size 8). The length of time each blossom remains open depends on the variety and is about six to twelve hours. The bagging is done the previous day, about 18 to 20 hours previous to pollination after all the flowers that should open that day have fully opened and have been removed. When the bag is opened for pollination the next day, usually about 10 to 30 fresh flowers will be found open. The stigma is receptive before the pollen of the same flower is released. The flowers are operated on as soon as possible after anthesis and before the anthers have opened their valves and shed their pollen. Since each flower has 9 anthers to be removed, and 30 flowers under a bag would entail the removal of 30 X 9 = 270 anthers, emasculation and disbudding the unopened flowers necessitates considerable interval before replacing the bag. It is safer, therefore, to pollinate first as soon as the bag is removed and then proceed to emasculate.

A significant fact noticed in this investigation is that the time of day at which the flowers open and close is definite for each variety of the avocado, and that it is only slightly modified by the weather conditions. Thus, in Florida, in February or March on mornings which are cooler than usual and when the temperature is about 45° to 50°, or on a very cloudy day, the flowers will open from a few minutes to about an hour later. Relatively, however, the succession in which they open and close and complete their own cycle is surprisingly uniform for each variety.

Thus, on a bright day in February or March, when the temperature is around 70°, the Puebla blooms will open at 6 a. m., those of the Taft at 8 a. m., the Waldin at 9 a. m., the Macdonald at 1 p. m., the Linda at 3, the Pollock at 4, and the Trapp at 5 p. m. Likewise, they shed their pollen at almost a definite time of day: the Linda at 7, the Trapp at 8, and the Fuerte at 9 in the morning; the Puebla at 1, the Taft at 2, and the Macdonald at 4 p. m. The Fuerte, Linda, Pollock, Queen and Trapp, which open in the afternoon, close in the evening (as do also the others), but without shedding their pollen. These shed their pollen the next morning at a definite hour, and, with the exception of the Fuerte, close during the day at a definite time anterior to the opening of fresh buds. The Linda and the Macdonald begin to close at 11 a. m., the Pollock and the Queen close at 12 noon, the Taft at 4 p. m., and the Taylor at 5 p. m. These observations were recorded from day to day for over a month.

With such a rhythm and regularity in the opening and closing of the flowers of each variety, it is not difficult, with the aid of a chart showing the progress of each, to ascertain the definite time of day when fresh pollen can be secured for pollination, and also the time in each case when pollination should be effected. It is also fortunate that

emasculation can be accomplished without disturbing the buds before they have opened of themselves. When the stigma is fully receptive the stamens spread out to a position at right angles to the style, and at this stage the anthers can be removed easily with the tip of small, long-handled surgeon's scissors or with slender-tipped embroidery scissors, without cutting away the perianth lobes and without hurting the flower unduly. At a later stage the perianth lobes become somewhat recurved before closing up, more distinctly so in the Fuerte. When the stigma is past receptivity it shows a browning of the tip. This fact, as also the open anther valves, can easily be detected with a hand lens, and later when the eye is trained to the shape of the anthers and of the stigma at different stages, their condition can be determined even with the naked eye. Since the stigma in the majority of cases observed shows a browned and withered appearance before the anthers of the same flower have opened their valves, the chances of self-pollination seem remote.



There are cases, however, in which the three stamens of the innermost series close up on the stigma in advance of the release of pollen, and protect the stigma from withering up by too prolonged exposure; in these cases it is possible that the stigma is self-pollinated. This is rendered more probable by the fact that the two proximal valves of this particular inner series of anthers open introrsely. An alternative to this conclusion is

that the closing up of the inner series of stamens around the stigma is an evidence that it has been fertilized and is preparatory to the closing up of the entire flower, just as happens normally in the case of the others after they have shed their pollen.

This point must be left over for a future investigation since want of facilities prevented the preparation of histological sections of these flowers at the time. In any event, this does not vitiate the attempt to pollinate by artificial means. In every case it is possible to handle the flowers for the operation before the closing up of the inner series and before any of its own pollen has been released.

With the aid of tabular statement B, appended hereto, it is possible, in the case of the varieties herein considered, to determine the exact time, correct to about 15 minutes, when the pollen of a desired variety should be taken in order to obtain it as fresh as possible, and when pollination should be effected in each case.

Thus, the pollen of the Waldin should be secured at 2 p. m., of the Taft and Taylor at 3 p. m., of the Macdonald, Queen, Fuerte, Pollock, and Trapp at 9 a. m. Likewise, the Wagner should be pollinated at 8 a. m., the Puebla at 9 a. m., the Queen at 2 p. m., the Fuerte, Macdonald and Pollock at 3 p. m., the Linda at 4, and the Trapp at 5 p. m.

The time indicated in the statement as "pollen shedding" is naturally also the time at which it is secured for pollination before it is blown off by the wind, but it will be found in many cases that the time of day at which a particular variety should be pollinated synchronises with the time at which pollen of the desired variety is just shed and is directly obtainable from the tree itself without having to store it in advance. In other cases, however, it has to be secured either the same day a few hours previously, or on the previous evening. Thus, in pollinating the Wagner with either the Trapp or Macdonald, the pollen can be obtained directly from the open blossoms of the latter, but the pollen of the Waldin for the Wagner has to be secured the previous evening at 2 p. m. For pollinating the Trapp at 5 p. m., the Queen pollen should be secured at 9 the same morning, while that of the Taft is available just two hours previously (i.e., at 3 p.m.).

For pollinating the Macdonald, the pollen of the Pollock should be obtained between 8 and 9 the same morning, and in the case of the Pollock, the pollen of the Macdonald should also be secured at the same hour.

In about three days after pollination, after all danger of the emasculated flowers receiving pollen from the outside is long past, it is well to puncture little holes in the bags in order to admit light and air into them. In the present experiments, it was found that three weeks after pollination in about 50 per cent of the bags, from among the ten to thirty flowers pollinated under each, one or two at least had set and in some as many as six to eight.

Supplementary

As a by-product of this investigation (so to speak) it is obvious that certain varieties interplanted with certain other varieties ought to give better chances for the setting of fruit.

Since the chances of self-pollination are remote, in an orchard where interplanting is not

done the chances of pollination and the setting of fruit under a natural process are limited by the following adverse factors:

I. The pollen available for fertilization on any day is the pollen of the flowers of the previous set which may have survived adverse weather conditions in the open field until the next day.

II. Most of the pollen that may thus survive is blown off by the wind before a fresh succession of flowers have had time to open.

III. The major portion of what is left over is enclosed within the flowers which close up before fresh buds open. The only exception to this, so far as could be observed, is the Fuerte whose flowers remain open with the pollen exposed while a fresh series of buds is opening. It is thus the only variety in which the chances of pollination are not decreased for want of interplanting.

Where interplanting is practiced, it seems natural to conclude that if other factors do not intervene, the chances of the setting of fruit are greatly enhanced by planting together varieties whose flowers, when they open, can be pollinated by varieties whose flowers opened one or two hours previously and whose pollen has been just released. Thus, we know (*vide* statement B.) that the Linda opens its buds between 3 and 4 p. m., while the Waldin which opened its flowers at 9 a. m., has its pollen released at that hour, and is available for the Linda until the flowers close in the evening. Likewise, the Waldin, when its buds are open at 9 a. m., has the pollen of the Linda available for it since the latter is shed early in the morning and its flowers remain open till 12 noon. In their season of bloom, although the Waldin normally comes into bloom about two weeks earlier, the latter part of its flowering season coincides with that of the Linda.

We therefore know that so far as mutual benefit for the setting of fruit is concerned, the Linda and Waldin make an excellent combination for inter-planting and from the standpoint of the grower, also, these two varieties give him a continuity of season in the maturing of fruit.

Like wise, a reference to statement B will show that the Waldin and Macdonald are a good combination. Other combinations for interplanting which are mutually beneficial are:

1. Fuerte and Macdonald
   Fuerte and Puebla
   Fuerte and Sharpless
   Fuerte and Taft
   Fuerte and Taylor
   Fuerte and Waldin

2. Linda and Puebla
   Linda and Sharpless
   Linda and Taft
   Linda and Taylor
   Linda and Wagner

3. Macdonald and Fuerte
   Macdonald and Taft
   Macdonald and Taylor
   Macdonald and Puebla
   Macdonald and Wagner
   Macdonald and Sharpless

4. Pollock and Puebla
   Pollock and Taft
   Pollock and Taylor
   Pollock and Wagner
   Pollock and Waldin
   Pollock and Sharpless

5. Puebla and Fuerte
   Puebla and Linda
   Puebla and Macdonald
   Puebla and Pollock
   Puebla and Queen
   Puebla and Trapo

6. Queen and Puebla
   Queen and Taft
   Queen and Taylor
   Queen and Wagner
   Queen and Waldin
   Queen and Sharpless

7. Sharpless and Fuerte
   Sharpless and Linda
   Sharpless and Macdonald
   Sharpless and Pollock
   Sharpless and Queen
   Sharpless and Trapp

8. Taft and Fuerte
   Taft and Linda
   Taft and Macdonald
   Taft and Pollock
   Taft and Trapp

9. Taylor and Fuerte
   Taylor and Linda
   Taylor and Macdonald
   Taylor and Pollock
   Taylor and Queen
   Taylor and Trapp

10. Trapp and Puebla
    Trapp and Taft
    Trapp and Taylor
    Trapp and Waldin
    Trapp and Sharpless

11. Wagner and Linda
    Wagner and Macdonald
    Wagner and Pollock
    Wagner and Queen

12. Waldin and Fuerte
    Waldin and Pollock
    Waldin and Queen
    Waldin and Trapp

Among the varieties considered in this paper, combinations other than those mentioned above are either of no value for interplanting or the benefit is not mutual, but one-sided.

Summary

The avocado, because of its high food value, is a fruit of immense possibilities and already a fruit of commercial importance.

Because of the inadequate supply at present, the avocado is bringing incredible prices in the northern markets.

Avocado orcharding in Florida already bids fair to rival the citrus industry.

From a strictly commercial standpoint the industry needs to be stabilized by confining production to one or two standard varieties. The standard varieties which should meet the requirements of the grower as well as the market have to be evolved by cross-pollination.

The avocado consists of three distinct groups or "races" called the West Indian, the Guatemalan and the Mexican. Of these, the standard fruit of the future should be a cross between the West Indian and the Guatemalan for southern Florida, and the Guatemalan and Mexican for northern Florida and California.

The varieties now in cultivation contain among them all the best qualities of the ideal

commercial type of fruit, and what is now needed is a combination of these qualities in desirable hybrids by a succession of cross-pollinations.

An analysis of the characters of the leading varieties now in the trade indicates what varieties should be cross-pollinated in order that a start be made in this direction.

A study of the flowers of the different varieties during the several stages of anthesis reveals to us facts of far-reaching importance.

These are:

1. That the time of day at which the flowers open, shed their pollen and close, is distinct and definite for each variety, but is the same for all trees of the same variety from day to day.
2. That a tabular statement showing the different stages of the opening, maturity and closing up of the flowers for each variety gives us the exact time at which pollination should be carried on in each case.
3. This tabular statement also tells us that certain varieties should be interplanted with certain others in order to increase the chances of the setting of fruit.

The investigation thus suggests the means of producing a better avocado, nearer the ideal fruit of commerce, and also the means of producing heavier and more regular crops by a more careful system of interplanting different varieties.

Season of Bloom	Name of Variety	6 A. M.	7 A. M.	8 A. M.	9 A. M.	10 A. M.	11 A. M.	12 Noon
From middle of February into March	Fuerte	Fls. open pollen not shed	Fls. open pollen not shed	Fls. open pollen not shed	Fls. open pollen shed	Fls. open pollen shed	Fls open pollen shed	Fls. open pollen shed
From middle of March	Linda	Fls. open pollen shed	Fls. open pollen shed	Fls. open pollen shed	Fls. open pollen shed	Fls. open pollen shed	Pollen shed, fls. closing	Pollen shed, fls. closing
From middle of March	Macdonald	Fls. open pollen not shed	Fls open pollen not shed	Fls. open pollen shedding	Fls. open pollen shed	Fls. open pollen shed	Fls. partly closed	Fls. closed
From middle of February into March	Pollock	Fls. open pollen not shed	Fls. open pollen not shed	Fls. open pollen shed	Fls. open pollen shed	Fls. open pollen shed	Fls. open pollen shed	Pollen shed, fls. closing
From middle of February into March	Puebla	Buds just opening	Buds just opening	Fls. open pollen not shed	Fls. open pollen not shed	Fls. open pollen not shed	Fls. open pollen not shed	Fls. open pollen not shed
From March	Queen	Fls. open pollen shed	Fls. open pollen shed	Fls. open pollen shed	Fls. open pollen shed	Fls. open pollen shed	Pollen shed, fls. closing	Pollen shed, fls. closing
From March	Taft	Fls. not open	Fls. not open	Buds just opening	Fls. open pollen not shed	Fls. open pollen not shed	Fls. open pollen not shed	Fls. open pollen not shed
From March	Taylor	Buds just opening	Buds just opening	Fls. open pollen not shed	Fls. open pollen not shed	Fls. open pollen not shed	Fls. open pollen not shed	Fls. open pollen not shed

Season of Bloom	Name of Variety	6 A. M.	7 A. M.	8 A. M.	9 A. M.	10 A. M.	11 A M.	12 Noon
From middle of February into March	Trapp	Fls. open pollen not shed	Fls. open pollen not shed	Fls. open pollen shedding	Fls. open pollen shed	Fls. open pollen shed	Fls. open pollen shed	Pollen shed, fls. closing
From March	Wagner	Fls. not open	Fls. not open	Buds just opening	Fls. open pollen not shed	Fls. open pollen not shed	Fls. open pollen not shed	Fls. open pollen not shed
From middle of February into March	Waldin	Fls. not open	Fls. not open	Fls. not open	Buds just opening	Fls. open pollen not shed	Fls. open pollen not shed	Fls. open pollen shedding
From middle of March	Sharpless	Fls. not open.	Fls. not open	Fls. open pollen not shed	Fls. open pollen not shed	Fls. open pollen not shed	Fls. open pollen not shed	Fls. open pollen shedding

Season of Bloom	Name of Variety	1 P. M.	2 P. M.	3 P. M.	4 P. M.	5 P. M.	6 P. M.	7 P. M.	8 P. M.
From middle of February into March	Fuerte	Fls. open pollen shed	Fls. open pollen shed	Fls. closing new buds opening	Fls. closing new buds opening	Fls. closing new buds opening	Fls. open pollen not shed	Pollen not shed, fls. closing	Flowers closed
From middle of March	Linda	Fls. closed	Fls. closed	Fresh fls. opening	Fresh fls. opening	Fls. open pollen not shed	Pollen not shed, fls. closing	Flowers closed	Flowers closed
From middle of March	Macdonald	Fresh buds opening	Fls. open-ing, pollen not shed	Fls. open pollen not shed	Fls. open pollen shedding	Fls. open pollen shed	Flowers closing	Flowers closed	Flowers closed
From middle of February into March	Pollock	Pollen shed, fls. closing	Fls. closed	Fresh buds opening	Fls. open pollen not shed	Fls. open pollen not shed	Flowers closing	Flowers closing	Flowers closed

Name of Variety	Season of Bloom	1 P. M.	2 P. M.	3 P. M.	4 P. M.	5 P. M.	6 P. M.	7 P. M.	8 P. M.
From middle of February into March	Puebla	Fls. open pollen shedding	Fls. open pollen shed	Fls. open pollen shed	Fls. open pollen shed	Pollen shed, fls. closing	Flowers closing	Flowers closed	Flowers closed
From March	Queen	Pollen shed fls. nearly closed	Fls. closed fresh buds opening	Fresh flowers open, pollen not shed	Fls. open pollen not shed	Fls. open pollen not shed	Flowers closed	Flowers closed	Flowers closed
From March	Taft	Fls. open pollen shedding	Fls. open pollen shedding	Fls. open pollen shed	Pollen shed flowers closing	Flowers closed	Flowers closed	Flowers closed	Flowers closed
From March	Taylor	Fls. open pollen shedding	Fls. open pollen shed	Fls. open pollen shed	Pollen shed flowers closing	Flowers closed	Flowers closed	Flowers closed	Flowers closed
From middle of February into March	Trapp	Pollen shed fls. nearly closed	Fls. closed	Fls. closed	Fresh buds opening	Fls. open pollen not shed	Fls. open pollen not shed	Pollen not shed, fls. closing	Flowers nearly closed
From March	Wagner	Fls. open pollen just shedding	Fls. open pollen shed	Fls. open pollen shed	Pollen shed flowers closing	Pollen shed, fls. closing	Flowers closed	Flowers closed	Flowers closed
From middle of February into March	Waldin	Fls. open pollen shedding	Fls. open pollen shed	Fls. open pollen shed	Fls. open pollen shed	Fls. open pollen shed	Pollen shed, fls. closing	Flowers closed	Flowers closed
From middle of March	Sharpless	Fls. open pollen shed	Fls. open pollen shed	Fls. open pollen shed	Fls. open pollen shed	Fls. open pollen shed	Pollen shed, fls. closing	Flowers closed	Flowers closed

Remarks—It is by no means claimed that this chronological statement is true irrespective of climatic conditions. It is possible that in different local areas the hours of opening and closing of flowers may be different for the same variety. But from what has been observed, there can be little doubt that there is nevertheless the same rhythm and regularity in the succession of flowers and the same cycle of progress for each variety in relation to the others.