

NEW ITEMS OF INTEREST

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As the title of my paper indicates, the subject matter will be more or less disconnected, but I wish to offer some notes on the avocado in Central and Northern California, a few observations on diseases and insects, a report of preliminary experiments on byproducts and some general notes on varieties.

In the interior valleys of California as most of you are aware, the avocado is being planted more or less extensively and it will be exceedingly interesting to watch the behavior of the different varieties under similar local conditions. The large seedling growing in Visalia is about twelve years old at the present time. According to information recently received, the seed which produced this tree was brought from Mexico and the seedling was kept for two or three years in the cellar to protect it from the cold. Having left the tree out one cold night with no injurious results the owner decided to plant the tree in the yard. Previous to the cold weather of 1913, when it was frozen back severely, it grew thriftily and bore small fruit having a long narrow neck. The tree is again in a thriving condition, however, although it did not bear any fruit in 1914.

There are two avocado trees growing at the Dallidet place in the city of San Luis Obispo, one 25, the other 20 feet high. They were grown from the seeds of some purplish-green fruits obtained from Mexico eleven years ago. Neither tree has ever fruited, but both were in bloom for the first time when the big freeze came in 1913. They were rather severely cut back and, of course, set no fruit that year. They are now growing vigorously and bid fair to be large trees before many years. The seeds came from the highlands of Mexico (Chihuahua) and they should be of a hardy type; the trees were no more injured by frost than were old seedling orange trees nearby.

I have recently been informed that there is a large avocado tree twenty years old, growing on the old Meissner place near Yountville, the seed having been brought from Central America.

There is a large avocado tree at least 25 feet high, growing on the University campus at Berkeley near the Center Street entrance. So far as I have been able to learn it has never blossomed, a fault which cannot be blamed on the climatic conditions at Berkeley, for seedlings often show this characteristic in more favored localities. It may be the same tree mentioned in the California Station Report for 1882, as follows: "The aguacate has now for three years withstood the winter frosts in a sheltered position and proves, perhaps, more strikingly than anything else grown here, how little we can foretell what will prove hardy."

At the Napa Soda Springs in Napa County a large avocado tree has been growing for some twenty-five years. The tree is about forty feet high and is rather slender, being

surrounded by other tall-growing trees. The fruit, of which a few were produced both in 1914 and 1915, is bright green even when ripe, and is said to be of good quality.

A bearing avocado tree of the thin-skinned type is located at Los Gatos, Santa Clara County. It is a seedling obtained from Santa Barbara nine years ago. The tree is now about fifteen feet high and during the past four years has produced fair crops of small, purplish-black fruits.

The success of these old seedling trees in such widely scattered localities presages successful results with plantings on a larger scale, and numerous inquiries are received by the Experiment Station regarding climatic conditions, cultural methods, and promising varieties. Commercial plantings have already been made in the foothills of Tulare County, in Sutter, Butte, and Glenn Counties, as well as in a few other localities of central and northern California. One fact has been clearly demonstrated by some of these plantings, namely, that water must be withheld in the fall and the trees properly hardened before the cold weather sets in, otherwise the tender growth will be cut back. It is this fact which renders it difficult to gather data on the frost resistance and hardiness of any tree, but especially of evergreen fruit trees which have several periods of growth during the season. Their hardiness depends to a large extent upon the degree of dormancy of the new growth. The fact that one grower finds the tree of a certain variety of avocado to be badly injured by ten degrees of frost, while another reports no injury, means little until all the circumstances are known, including the condition of the tree in each case, the state of the weather before and after the cold spell, and the duration of the low temperature. A variety should not therefore be condemned on account of one or two instances of frost damage unless these facts have been taken into consideration. The original tree of the Meserve avocado, was frozen back more or less severely in the winter of 1912-13, but practically everyone is agreed that the damage was due to the sappy condition of wood induced by copious watering of the asparagus bed near which the tree is growing.

Another point which may be emphasized is the maintenance of healthy growth in the tree by proper cultivation and judicious fertilization. There is little, if any, evidence to show that an avocado and a citrus tree require any different fertilizing elements. Since the foraging power of the roots is dependent upon the physical condition of the soil, the importance of keeping it well supplied with humus and of maintaining a good soil texture cannot be overemphasized. For young trees as well as for old trees the basin-mulch system seems practicable. By keeping the basin well supplied with strawy manure and other decaying vegetable matter, both the humus content and the proper texture of the soil can be economically maintained. Experiments in other countries have shown that the avocado tree responds to judicious fertilizing, although excessive amounts of nitrogen appear to increase the fiber content of the fruit. Liquid cow manure has been found good for seedlings. Wester, in the Philippines, uses the following formula for many kinds of tropical plants, applied at intervals of two or three weeks:

Nitrate of Soda	275 grams
Sulphate of potash, 49 per cent	125 grams
Acid phosphate, 16 per cent	350 grams
Water	100 liters (105 qts.)

We frequently receive complaints and specimens of a leaf trouble in which the leaves

begin to turn brown and die back at the tip and along the edges, and occasionally the twigs are affected in a similar manner. Specimens received for examination ordinarily show no fungus present, but in a moist chamber there develops an organism, determined by Mrs. Flora Patterson of Washington, D. C., as *Colletotrichum gleosporioides*, the same fungus which attacks mango, avocado, and citrus trees in Florida and the West Indies. In California this fungus appears to be of little practical importance, for although it has long been present in the citrus districts, it very rarely attacks healthy trees as an active parasite, although it may cause tear-staining and decay of the fruit. On senile leaves or younger leaves weakened by sunburn, frost or otherwise, it causes the well-known dead spots, on the surface of which may be seen the minute black fruiting bodies of the fungus. This leaf trouble of the avocado is undoubtedly primarily clue to physiological rather than pathological causes. By remedying unfavorable soil or moisture conditions and promoting a vigorous growth of the trees it would seem that this weakness can be more or less overcome.

Some specimens of the Chappelow avocado received in September, 1915, were thoroughly ripe, and two showed signs of a peculiar softening evidently due to the action of some fungus. The fruit was therefore submitted to Prof. Home of the Division of Pathology, Berkeley, who later submitted this report, which I wish to include with my paper:

REPORT ON FUNGUS ROT

"On the first two fruits brought to me on September 21st it was very evident that several types of decay were active and several organisms present. The most frequent type of decay consisted of small, slightly sunken spots, which looked as though there had been simply a dent made by rather small fingertips, and some white fungus was growing in the hollow. These spots were of rather frequent occurrence, scattered over both of the fruits submitted. I have not yet been able to determine in a way satisfactory to myself whether this type of rot is due in all cases to the same organism, or whether several kinds of fungi may cause the same kind of injury. The fungi growing in these spots and on the surface of the fruit seem to be rather numerous and varied. I have cultivated a *Fusarium* of a rather peculiar type, an *Alternaria*, which, so far as I can tell up to the present time, might be identical with the fungus causing black heart of oranges, and a small fungus producing very definite fruiting bodies in which no spores have yet formed, which might be some form of *Phoma*. There were also developed on the fruits which were kept in a moist dish, some *Penicilliums*, *Cladosporium*, *Acremonium* or *Sporotrichum*, and some other fungi not certainly recognized. It will be seen that the number of fungus forms which appear on overripe avocados are very numerous.

"In addition to the fungi which developed on the fruits in moist chamber, bacteria of several kinds also developed. The form of bacteria which has come to predominate in these spots is one which forms a copious sticky brown mass, and when it becomes slightly dry, a wrinkled pellicle on the surface. The odor is offensive but not exceedingly strong, nor is it like the odors given off by putrefying meat or vegetables, such as cabbage and turnips.

"From examination of the decaying fruits it appears that neither the fungi mentioned nor the bacteria penetrate in great quantity into the fruit, nor do they appear to have a very rapid or pronounced effect in causing softening and decomposition of the flesh. While they would doubtless spoil the fruit for market purposes, they represent rather superficial decays, and the fruit could be utilized after they had commenced to make their appearance on the surface without great loss, provided they did not become very active until time when the fruit was ready to use. As to whether any of these organisms cause the spoiling of the flesh in the early stages of their attack, I have not been able to determine as yet.

"However, one of the fruits brought to me on September 21st had a rot which from its appearance would lead very promptly to the suggestion that it might be a very important matter for the avocado grower. The fruit of this set was Chappelow and specimens were very nicely developed individuals of this very attractive little variety. The spot in question was about one and one-half inches in diameter, with the center located near the base of the neck of the fruit. The color was a dull greenish, considerably lighter than the fine deep purple of the normal fruit. In the center of the spot about half the area was rough and somewhat wrinkled and blackish, while the outer part of the spot was wrinkled somewhat, as though the flesh below had sunken and the skin become thinner and more transparent, but is still as glossy as in the healthy condition. Some whitish tufts of fungus were emerging here and there over the surface, especially near the center of the spot, and it is almost certain that more than one kind of fungus was growing in this area. It seemed apparent at once that we had to do here with some specific rot of the avocado fruit of a rather more violent nature than in the spots which were thickly scattered over the surface of the fruits.

"On microscopic examination some fruiting bodies were found below the surface in this large rotted area, and spores were found in them which were very pale yellowish, one-celled and formed on short pedicels.

"In order to discover the cause of this peculiar rot the surface of the fruit in the outer area of the spot was sterilized by washing with formalin, and with hot needles a little of the flesh was removed from below the surface and planted in an artificial culture medium. Some of this same material examined microscopically showed large fungus threads here and there passing through the flesh. Bacteria were not recognized in the deeper layers. Bacteria cultures were also made from this flesh by macerating some of it in water and diluting by the ordinary bacterial methods. Only one set of such cultures was made, but absolutely no bacteria grew, indicating that this decaying flesh does not contain bacteria. In two days after planting the pieces of decayed flesh in artificial medium vigorous growth of a strong fungus mycelium developed from every one of the plantings. This fungus has been studied in several different culture media and has been inoculated in three different avocado fruits to date. One of these fruits was already well advanced with other types of infection when inoculated, and satisfactory results were not secured.

"One fruit, which was a very beautiful ripe specimen of the Topa Topa, was inoculated on October 13th at two points by introducing some of the fungus below

the skin. At this writing, October 18th, these two spots are showing distinctly lighter areas about an inch in diameter, and it is very evident that the fungus is producing in this fruit the same type of rot as was found in the original fruit of the Chappelow. We have, therefore, apparently proven that this particular fungus is the cause of the very menacing-looking case which was making its appearance on the Chappelow fruit.

"That this decay is a serious matter is very evident from the rapidity with which it spreads in the fruit and its effect in the flesh. Several days after the first examination the original spot was cut into and it was found that the flesh was affected to the axis of the fruit. Although not very strikingly changed in appearance, this flesh darkened more rapidly than the unaffected part of the fruit and had a very disagreeable, mildly bitter and disgusting flavor.

"It will be of great interest to know what this fungus shall prove to be from further study. According to present indications it is not distinguishable from the fungus causing the black rot of apples in the middle states. The same fungus also causes a very destructive type of canker on the twigs and limbs of apple trees, and from reports received from orchardists and friends in the middle states I judge it constitutes one of the most important factors in the killing out of the farm orchards in that region. The same fungus has been found in twigs of apple by Mr. Carrol Rodgers, of Watsonville, and cultivated and studied by him while a student in our laboratory. Apparently owing to the climatic conditions prevailing in California, this fungus is not so destructive here as in the middle states, but it is evident that it exists here. Abundant moisture and warmth at the same time are conditions which probably favor its development, and a combination of moisture with cool weather is probably not so favorable to it.

"Professor Fawcett has called attention some years ago to the fact that this black rot fungus of the apple is closely related to the very destructive decay organism of citrus fruits which causes the greenish black rot of lemons and other citrus fruits. It is also interesting to notice that in a recent report by Professor Earle and Mr. Rogers, from the Isle of Pines, this second fungus is reported as the most serious one with which they have to deal in the Isle of Pines on citrus fruits, causing a stem-end infection of the fruit and a rapid decay, as well as infection of branches and destruction of upper parts of the tree. They also call attention to the fact that the same results may be brought about by infection with the bitter rot fungus of the apple, and seriously question whether there is much, if any, distinction to be made between the two fungi. It should be understood that we are not stating that the rot fungus obtained from the avocado is identical with the two fungi mentioned, *Sphaeropsis malorum* and *Diplodia natalensis*, but that the fungus from the avocado has developed spores in pycnidia in exactly the same manner as in the other fungi, and the growth of the avocado fungus is not distinguishable in character from the growth of *Sphaeropsis malorum* which is being cultivated in our laboratory by one of our students, Mr. Hahn, and which has been submitted to Mr. Hesler, of Cornell University, and is in his judgment the true *Sphaeropsis malorum*. Inoculations on avocado fruit with the fungus from apple have not yet produced exactly the same result as inoculations with the avocado fungus, but there is still

time for the same conditions to develop.

"It may be permissible to remark that the decay processes concerned in the avocado will be of an entirely different character from decay processes in the more watery and acid fruits, being more comparable to the decays of bananas than to those, for instance, of oranges and peaches, or still more like those of olives. Bacteria of various kinds will be able to grow in the avocado flesh in all probability, not being restrained by the presence of acids, and it does not seem probable that we shall have many organisms which will cause the rapid collapse of the avocado flesh, as do various fungi affecting citrus fruits and the acid deciduous fruits. However, we have seen enough to realize that there will be something for the plant pathologist to study in connection with the fungus and bacterial infection of avocado fruits in connection with their harvesting and delivery to the consumer.

"Let us hope that these fungi are not able to gain entrance easily into the avocado flesh, since the fruits will doubtless be more acceptable to the consumer in their fully ripened condition than in a condition of partial ripeness. We should not, however, relax our vigilance, so that we may be able at the earliest possible moment to cope with any problem of this nature which may arise. It is hoped that studies here described may be carried a little farther, so that we may know definitely the character of the rot produced by each particular type of organism, and some other facts which may be of practical interest. It is not contemplated, however, to proceed with what may be considered a thorough investigation of this subject at the present time, but only to give some preliminary idea of some of the problems which may be involved."

(signed)

"WM. T. HORNE."

INSECT PESTS

The number of insect pests attacking avocado trees so far in California is small. The list includes the mealybug, greedy and black scales in Ventura and the southern coast counties; the omnivorous looper on seedlings at Berkeley; the twig borer, **Polycaon con-fertus**, and a chafer, **Serica alternata**, on nursery trees in Ventura County, and an unidentified miner, the galleries of which have been noticed in the bark of tender branches in various parts of Southern California. According to the horticultural commissioner of Ventura County, the work of the twig borer was similar to that on other trees, namely, boring into the tree at the forks of the branches. In some cases where the trees were small the cavities made were equal to about half the diameter of the limbs on which the insects were working. In such cases the trees were so weakened that a heavy wind would break them off. Digging out the beetles by hand proved the surest remedy. The *Serica* was found working on avocado foliage in the Fillmore section, where it is found very commonly on walnut trees. It feeds only at night, burying itself in the ground during the daytime. Some of the avocado trees were almost defoliated. Arsenical sprays did not prove effective as a remedy, so the young trees were covered with muslin as a temporary protection. On large trees the damage done by these chafers would seldom be appreciated.

FOOD USES

In all countries where the avocado is produced its principal use is as a fresh fruit. A few recipes are given in which the pulp is cooked with vegetables; it is also commonly used to flavor soups. The subject of by-products has received some attention in other countries, and recently experiments have been made at the University of California to see if some methods could be worked out by which the pulp and seeds of the small seedling could be utilized. Naturally the possibilities of producing a commercial oil from the fruit have been first considered.

The Florida Experiment Station in 1902 made some preliminary investigations of avocado oil, but owing to a change in the station staff about 1903, the work was dropped and has never been taken up since. Brant, in his "Animal and Vegetable Fats and Oils," 1897, states that the oil is of a slightly dark greenish-brown color and consists of 30 parts of olein and 70 parts of lauro-stearin and palmitin. Olein is liquid and the other two fats are solids, stearin -having the higher melting point. Therefore the larger the proportion of olein contained in a fat, the softer it is, while the greater the proportion of stearin, the higher its melting point. In olive oil the proportions are just reversed, the average sample containing 28 per cent of palmitin and stearin and 72 per cent of olein, which accounts for its greater liquidity. The oils from different varieties of olives vary considerably in the percentage of olein present; some are therefore more liquid than others. Whether this same variation occurs in the oil of different varieties of avocados has not been investigated, but it is not likely to be sufficient to materially affect the quality of the product. In his book on "Vegetable Fats and Oils," 1902, Andes includes avocado oil in the list of fats of no commercial importance. In foreign countries it is known under various names, such as Huile de avocatier, Avocado oil, alligator pear oil, grasa persea, and advogatofett. It has been used medicinally to a small extent in Brazil and elsewhere. Alligator pear soap is manufactured in Guatemala and can be purchased in this country. Cheaper forms of fat, however, are ordinarily available for soap-making, and such a product probably contains only a small percentage of avocado oil. According to Collins (Bulletin 77, U. S. D. A.), the ladies of Guatemala sometimes extract oil from- avocados by pressure. They never use it in cooking, but say it is fine for the hair.

In the preliminary experiments at the University by Mr. Mitra, a graduate student, it was found difficult to press out the oil in an ordinary press, since the flesh is so soft and fine the two will not separate readily. The slices of flesh were therefore dried in an oven, the pieces ground up and then put in a press. By the ordinary method of pressure it was found that only about 15 per cent of the oil could be obtained. The resulting oil, samples of which I have with me, is fairly clear, dark green in color, somewhat bitter but not unpleasant to the taste. It is doubtful whether the oil will be of much commercial value. Larger quantities may be extracted by ether, gasoline, or other solvents, but the resulting oil is affected both in color and flavor. The process of extraction is a little more expensive than by pressure.

Some experiments have been made in the production of a paste, but they have not progressed sufficiently to be conclusive. This form of by-product looks promising, however, its success depending upon proper sterilization of the pulp so that the flavor will not be affected. The addition of salt, lemon juice, vinegar, or similar flavoring

materials, is advisable.

Another by-product for which a demand might be created is avocado flour. For this purpose the seed is removed and pieces of the pulp dried in an oven. Slow drying in the sun is not advisable, as this is liable to develop a rancid flavor. Thin-skinned fruits need not be peeled, as the taste of the skin is not objectionable; dark skins will, of course, make a dark-colored flour. The dried pulp is ground finely, seasoned with salt, sterilized, and preserved in a sealed can. It may be used for flavoring soups or cooked vegetables of different kinds.

The seeds of the avocado, when fresh, contain a liquid which turns red when exposed to the air, and some writer a century or more ago stated that for this reason the juice could be used as indelible ink to mark cloth. This statement has been copied by numerous writers ever since, but it is doubtful whether the seeds were ever used to any extent for this purpose, even in Mexico. The bitter taste may be removed from the seeds by boiling, after which they have a not unpleasant nutty flavor. By successive treatments in sugar solutions of increasing strength a confectionery may be prepared from these boiled seeds. A few samples made in this manner have a pleasing flavor and suggest a means of utilizing the seed. In Brazil the seeds are said to make a good powder that can be used in the preparation of soup. It is doubtful, however, whether they will be of much value for this purpose in comparison with the flour from the pulp.

VARIETIES

In conclusion, I wish to present a few general notes regarding varieties. I think it especially important in this early stage of the industry to caution growers and nurserymen against needless multiplication of varieties. A seedling tree which comes into bearing should not be propagated and distributed as a distinct variety unless either the fruit or the tree has characters as good as or better than some other variety already existing. There will probably always be room for improvement with fruit varieties, and it is very desirable to get avocado fruits with a greater proportion of flesh and less of seed, with richer flavor, less fiber, better shipping and keeping qualities. Characteristics of the tree, such as productiveness, hardiness, resistance to disease, and lengthened season of bearing fruit, should also be watched for and improvements noted. Unless a seedling does show some such improvement it should be budded over, unless the owner wishes to sell the fruit as seedlings, just as some oranges are still sold.

For the reasons just mentioned, it seems desirable to have some systematic method of judging the fruit of any variety of avocado. I have therefore devised the following score card, which, I believe, will serve for all types of the fruit. It is only tentative, however, and I invite discussion:

Score Card for Avocados

Size (uniformity).....	10
Form	5
Stem	2
Skin	33
Color	10
Finish	5
Surface	6
Freedom from blemish.....	12
Flesh	40
Color	5
Thickness and amount.....	10
Flavor	5
Texture	5
Quality	10
Freedom from fiber.....	5
Seed	10
Size	8
Condition in cavity.....	2
Total	100

Avocado Standards

Size. Avocados may be of any size from small, 2 or 3 inches in diameter, to large, 5 inches or more. Medium sizes are most desirable, those weighing from $\frac{1}{4}$ to $\frac{1}{2}$ pounds. Sizes should be uniform among the fruits of any one variety submitted for exhibit or judging.

Form. Fruit must have shape typical of the variety. Round and pear-shaped fruits are more desirable than bottle-necked or elongated.

Stem. Stem should show a smooth cut. It should be well set and firm. Deduct one point for each missing stem.

Skin. Color should be attractive, whether green or purplish-black. The skin should have a good finish, glossiness and clearness of coloring being desirable. The surface need not be perfectly smooth, but warty or exceedingly rough fruits should be discounted. Fruit should be free from blemishes such as cracks, wind scars, or abrasions.

Flesh. The flesh should be of a good butter color, with very little green near the skin. The largest, possible amount of flesh is desirable. The flavor should be rich and nutty, the texture soft and buttery, and the quality as high as possible. The less fiber the better.

Seed. The seed should be small and tight in the cavity.