

## PROGRESS REPORT, MARCH 6, 1931, ON AVOCADO DISEASE INVESTIGATIONS

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A. Diseases on which progress of a positive kind has been made:

Tip-burn.

Carapace spot and Wounds.

Sun-blotch.

Surface rot or Dothiorella rot of softening fruit.

B. Diseases on which some progress has been made, but the problems are not yet solved:

Apoplexy.

Cankers on green stems.

Ring-neck.

Kink-side.

Thompson spot.

End spot.

**Apoplexy or collapse**, the sudden drying up of a greater or less part of a tree is clearly in some cases due to failure of roots to supply sufficient water. There may probably be various causes for root failure—we need more study of the behavior of avocado roots.

**Cankers on green stems.** Large black spots on green twigs look like a violent attack by some definite parasite. However, considerable study has failed to find the offending parasite. These cankers are not yet explained, but ordinary measures of sanitation and the use of fungicides are not liable to help. Measures directed to favor the general health of the plant have most promise.

**Ring-neck.** Ring-neck of Fuerte has also baffled our attempts at explanation thus far.

**Kink-side.** Avocado fruits are slightly oblique or skewed, as if they were plastic bodies, one side of which had been pushed up and the opposite side down. Kink-side is a failure of the flesh to expand between the center of the fruit and the upper end of the high side, or shoulder—a defective development. In early stages the surface is green and appears normal, except for lack of expansion, and if cut, the flesh of the depressed

area appears normal, though it turns dark sooner after cutting than the other parts. The area of defective growth frequently develops a large dark spot which slowly dries out and may cause the loss of the fruit.

Kink-side is believed to be more severe on weak, overloaded trees. It may usually be observed on the variety Spinks, but this may be because this variety is very fruitful.

**Thompson spot.** Certain dark spots on immature but usually well-grown fruits of various varieties look like bruises, but on careful study apparently are not due to mechanical injury. They differ from carapace spots in that they do not heal perfectly and deterioration of the flesh below the spot comes on gradually and the fruit is lost. Best fruit and most vigorous trees suffer most.

**End spot.** End spot is the name given by Dr. Coit to the common trouble of mature fruit on the tree, in which the lower end dries and shrivels up. I am using the name End spot to refer exclusively to mature and over-mature fruit. It appears to be a simple drying up because the tree is unable to keep the fruit supplied with water. Following the heavy north winds of early winter, there appear regularly a large number of End spots on Fuertes. The drying may consist in the formation of a number of pin-head sized sunken dark spots, or these may be so numerous as to form a continuous dark area—speckle, or scald. With drying there often comes cracking. Cracking may be greatly increased by rain.

Blakes, this year at the Citrus Experiment Station, were ready to use for fully a month before End spot appeared. Prompt harvesting seems to be the solution for this trouble. If fruits remain on the tree, drying proceeds and the flesh, which at first was not injured, becomes shrunken, darker, and finally entirely spoiled. A seedling of unknown origin at the Citrus Experiment Station shows color about the time maturity is attained, and coloring and maturity proceed from the stem end downward. Nature in this case would seem to have made an extra effort to help us with the End spot problem. In some varieties ripening proceeds from the lower end upward. This would seem likely to make End spot worse.

We have endeavored to classify all ordinary fruit blemishes as either carapace (healed surface injuries), Thompson spot (physiological breakdown of immature fruit), End spot (surface breakdown of mature fruit), and mechanical injuries. However, many puzzling cases occur. Drying and the general water relation are probably important especially with later blemishes.

**Tip-burn.** The work of Dr. A. R. C. Haas has shown that tip-burned leaves contain more salt than normal leaves. This accumulation of salt may be due to (1) excessive drying of wind, (2) actual shortage of water in the soil-drouth, (3) excess salt in the soil, (4) excess salt in the irrigation water, (5) hardpan preventing drainage and so bringing about accumulation of salt in the soil, and (6) poverty in plant nutrients, especially nitrogen, causing the plant to take up more water than if the soil were fertile and so to take up more salt. (Year Book, California Avocado Association, 1928.)

**Carapace spot.** Carapace spot is a name I have given for the rather hard, dry, corky blemishes usually included under the designation of "limb rubs" by fruit handlers. Carapace spots are of variable size, from very small to covering nearly the whole fruit.

The shape also is various, the boundaries of the spot being often in part rather straight. Frequently the spot is extended into a pointed, narrow streak.

Surface of the spot is a smooth, hard, brown substance, usually broken into angular areas of various sizes, with rough grayish corky strips or cracks between. This figure suggested the marking on a turtle's back, and so the spot was called "carapace."

Depth of the hardened tissue is usually slight, though sometimes the cracking penetrates considerably. The flesh usually is uninjured.

It is evident that the outer layers of the fruit were killed and dried at an early stage—the dead surface tissue, not being elastic, was cracked by expansion of the fruit in growth. Just how these spots come about was a matter of considerable uncertainty. Any heavy object, hanging in a tree, would be more or less scratched and injured by striking hard surfaces, and doubtless the large fruits suffer injuries much as a baseball hanging in a tree would. We would class such injuries as wounds, not as carapace spots. Carapace, however, is not a simple abrasion, but involves healing processes in the surface layers of the fruit tissues.

We were surprised to find how early in the life of the fruit the carapace spots are formed. About as soon as the blossom has shed from the tiny fruit, carapace may begin to appear. In most places it could be clearly seen that carapace started where the tender fruits touched some definite object, as a fruit stem or the edge of a leaf. At the earliest stage the spot is not cracked or visibly torn or broken, but is merely a smooth, slightly dried area. Apparently contact with a hard or rough object is not necessary, but touching a smooth and slight object is sufficient in the early fruit stages. Very soon the surface cracking begins, and surface healing processes give rise to the thick and corky aspect of the mature fruit. Several distinct carapace spots may appear on a fruit, caused by contact with the same object, the fruit being passed along by growth in the length of the stem.

We were rather surprised to find how much cutting, scraping, stabbing, etc., a young avocado fruit would stand. Also, slight wounds did not cause the small fruits to drop. We did not exactly reproduce the carapace spots by artificial injuries. The picture for this spot is not complete, but we think we have the main features.

How carapace is to be prevented is not clear. Somehow, Fuerte fruits escape more than some others. If desired, carapace fruits may be thinned out on overloaded trees at any early stage, thus getting rid of a certain number of culls.

At the grading table carapace is evidently more important than all other blemishes of the avocado.

**Wounds.** A heavy fruit inevitably must suffer mechanical injuries, as for instance during our heavy north winds. Fortunately the avocado on the tree while immature is very little subject to decays following injuries. On separation from the tree, however, softening soon comes, and the resistance to decay rapidly disappears, so that wounded fruit is subject to several sorts of decay.

Sheltered situations, windbreaks, and fortunate shape of tree are well worth consideration in connection with preventing wounds.

**\*Sun-blotch.** Sun-blotch, according to our studies, is probably not connected with sunburn, but the name is a good one nevertheless. Studies with Dr. E. R. Parker and information from reliable sources indicate clearly that sun-blotch is a systemic disease.

\*See Dr. Home's article, July, 1931, issue Monthly Bulletin, State Dept. of Agric.

Sun-blotch is a systemic disease of the avocado tree which affects some of the fruit. Young Caliente trees at the Citrus Experiment Station, in fairly good condition, produced last year a fair crop, but nearly all the fruits were culls from sun-blotch.

Marks of sun-blotch on the fruit consist of deep grooves extending from near the stem end towards the lower end. On green-colored fruits these grooves are light in color, but as purple fruits mature the streaks often become brilliant red-purple. Nearly all the pronouncedly sun-blotched fruits will be rejected before sending to market. However, a fruit sometimes is seen on the grading table with a very small or short sun-blotch streak.

If a sun-blotched fruit is cut across, white spots show that there are lighter streaks in the flesh. Some of these white streaks lie just below the surface grooves and some are in the flesh not connected with surface grooves, so that sun-blotch does change the internal structure and condition of the fruit, but apparently not in a way to spoil its usefulness.

It might seem desirable to destroy all avocado trees with sun-blotch. However, some very excellent trees show a very few grooved fruits or twigs. We have seen this condition in some fine Taft trees, and at the Citrus Experiment Station we have two good Fuertes each of which has a very few grooved twigs and, very rarely, a slightly-marked fruit. Such trees should, of course, be avoided in choosing scions, but we hardly have the courage to recommend their destruction.

A diseased tree cut off gives rise to diseased shoots and if healthy scions are set in it they also become diseased. If a diseased scion is set in a healthy stock it grows up with the disease, and sprouts from the healthy stock also have the disease. This indicates that the cause is an invisible virus which spreads through the living plant, as occurs in the sugar-beet blight or curly-top disease.

All badly-affected and inferior trees with sun-blotch should certainly be destroyed. Large and slightly-affected trees constitute a puzzling problem. Such trees certainly should not be used for propagation, but we are not ready to demand their destruction.

Seedlings from diseased trees have thus far been healthy, which is the usual behavior with virus diseases.

Our work is being continued along the lines indicated to make more sure that our results are correct. A line of work which should be started now is to watch for new cases on seedlings and to try to find out whether some specific insect is bringing the disease from diseased avocados or from some other plant.

**Spoilage of Soft (Ripe) Fruit.** Decay and natural over-softening are not easy entirely to distinguish. An over-soft or over-ripe fruit has lost all detectable sweetness and freshness of flavor and has something which may be called a slight rancidity. However, like slightly stale cream, it may be acceptable if combined with more sprightly or tasty materials.

The active decays with which we have had to deal in California may be grouped as follows:

**Bread mold, black mold or Rhizopus decay:** Bread mold, or *Rhizopus*, is the outstanding enemy of moist food materials and especially of juicy fruits. On the avocado it is a wound parasite of softening fruits, and needs moderately high temperatures. Moisture also favors it. The flesh is rapidly invaded by the strong, coarse fungus threads, and becomes watery and completely spoiled.

Windfall and injured fruit should be placed promptly in as low temperature as the fruit will endure and soften normally.

**Eye rots:** Several fungi of the common molds start growth at the stem wound and cause gradual decay. Often the decayed part shows small cavities lined with white or variously colored mold. Cutting stems close and drying is usually a good practice. Still better results would probably be had by dipping the cut in denatured alcohol and, when dry, in melted paraffin.

**Surface rots.** These may be in part caused by the same molds as the eye rots. They start up on fully-ripe or over-ripe fruits and are favored by wounds or moisture, but finally develop even under good conditions.

Anthracnose has been one of these ripe fruit diseases in my observation, but Dr. Fawcett has seen it evidently causing injury on the tree.

**Bacteria.** Following various decays and over-ripeness, bacterial decay comes in for the final stages of spoilage. Various sorts of bacteria are doubtless concerned, as indicated by white or yellow drops of moist material coming out like perspiration on spoiling fruit. They have not been extensively studied but are probably similar to the bacteria causing decomposition of meats and other food materials.

**Surface rot or Dothiorella rot.** A disease of ripening (softening) fruit has come to my attention during the present winter with which I was not familiar before. No sign of the trouble shows on the hard fruit, but when the fruit "breaks" to soften, small dark spots appear on the surface. At first these spots are not readily distinguished from the ordinary spots of mature and softening fruit, but the *Dothiorella* spots are usually a little lighter and spread more irregularly. If the air is dry they tend to sink somewhat, but if moist, they become tender and may be slightly greenish tinged or glaucous. A rot of the skin and outer flesh occurs and a rancid odor develops. If the fruit could be used promptly little loss should result. However, keeping and marketing are interfered with.

Dipping in various chemicals and in hot water, carried on with Mr. Newton of the Calavo Growers, has failed to accomplish control.

What is believed to be the same fungus as that in the fruit is found in dead avocado twigs in the tree, but these studies are only well started.

Citrus fruits suffer occasional small loss in California in the more moist coastal climate from fungi of the *Dothiorella* type, but the trouble has never been very serious or general.

In Florida, where loss from stem-end rot of citrus fruits caused by fungi of the *Dothiorella* type may be serious, control measures consist in removing dead twigs and

spraying with Bordeaux.

I think I ought to remark that Mr. McLean and Mr. France are doing quite a bit of my work, but they really are better prepared and know better how to do it than I do. I have about all that I can handle in my laboratory in Riverside and if I undertook to do some of this field work, I am sure I would not get it done as well as they are doing it. I think you are very fortunate to have men in your counties who are capable and willing to take up your local problems and work them out.

A good many of you are considerably concerned with this question of *Dothiorella* rot. I have to confess I did not know what *Dothiorella* rot was a year ago, though I mentioned something very much like it in the first report your Avocado Association got out. You know, we do not get our knowledge about avocados out of text-books written in Germany or Russia. We have to find out the facts ourselves the best we can.

Now there are a lot of spots that come on avocados when they begin to soften. Since we have begun to hear so much about *Dothiorella* rot, people think that every spot that shows up on a fruit is *Dothiorella*. That is not true. A Fuerte avocado will begin to get black spots when you keep it in the refrigerator, when there isn't any *Dothiorella* in those spots. Take them out of the Frigidaire before the dark spots appear and keep them out until they are soft enough to use; then you can put them back. In the last few days I have been working with some spotted fruit in my laboratory. All of the dark spots practically have some fungi (not *Dothiorella*) in them but they did not all have a parasite in them when they started to soften. Some had a condition we do not altogether understand, perhaps like scald in apples. Some of the spots may have been caused by fungi. Some of the fruits have probably had a natural physiological breakdown. But no matter what the cause the spots very quickly get infected with fungi.

I believe that *Dothiorella* rot is nothing new, but has been here all the time. However, because of special conditions, it came to attention this year. The rot which causes the spots in the fruit does not appear until the fruit begins to soften. If you will use the fruit when it is best to use, that is when it first softens, you probably will not see anything at all. But when the fruit is soft on the stand waiting for somebody to come along and buy it, it does not last as long with these *Dothiorella* spots as without the spots. It is quite a superficial rot at first but nevertheless it does do a certain amount of harm. Of course, when the fruit is soft, other rots will injure it and break it down but they will not do it as rapidly as the *Dothiorella* and for that reason it is serious.

Now where does this *Dothiorella* fungus come from? It is not just drifting around in the atmosphere, moved by the wind. You know some of the other fungous spores are carried by wind and go up into even the high atmosphere— they have been found there by spore traps carried by airplanes. *Dothiorella* is not the type of fungus that goes up into the upper atmosphere. It is not light or fluffy and probably has very little movement in the air except when it is washed down by water from an infected twig or leaf onto the fruit. We have found it in dead spots in the leaves and in dead twigs taken from the trees. The rains must wash it down on the fruits. The *Dothiorella* infections on the leaves come especially in tip-burned leaves. You can't do much with the infection in the leaves. There are too many. But the leaves come off after a while and this *Dothiorella* fungus has not any way of getting back up. You give some molds a little impetus and

they will float right up into the air but we think it is not so with *Dothiorella*. If the dead twigs stay in the tree the dead ones (not the living twigs) may get infected with this fungus. At the exhibit here you will see some twigs that have the fungus. Probably you won't be able to see the fungus without a lens but you can see the type of twig that carries it.

We do not understand why the avocado tree has so many dead twigs. Probably all normal avocado trees have a lot of dead twigs. It doesn't mean anything serious as to the health of the tree but is a kind of natural pruning. However, you see these dead twigs get infected. Then, of course, the spores may be washed down over the leaves. Though efficiency of the measure is not yet entirely proved, I am strongly recommending pruning out all dead twigs and branches in the localities where *Dothiorella* occurs.

## QUESTIONS AND ANSWERS

### Sun-Blotch

November 22, 1930

**Dr. Coit:** I have taken it upon myself to urge an investigation at the Citrus Experiment Station. Dr. Parker and Prof. Horne are now working on this problem. Sun-blotch is a condition that has been present ever since the beginning of the industry but it is only in the last two or three years that we have recognized it as a diseased condition of the tree. Then we noticed that the trees did not grow well, some of the limbs came out, drooped over and hung down looking like weeping mulberry trees rather than avocados. There were many branches and twigs streaked with yellow and white and extremely brittle. Later on we noticed a certain proportion of the fruit gnarled and twisted and covered with peculiar spots and blemishes. We had no knowledge or name so I gave it the name "sun-blotch" to distinguish it from sun-burn. It has been discovered at the Citrus Experiment Station that if you take bud-wood or graft-wood from a sun-blotched tree and put it into healthy stock, it will not only result in a sun-blotched tree but will go backwards through the stock and affect even the root which previous to the graft was perfectly healthy. It is highly transmissible by bud-wood or graft-wood. Therefore, it pays to select your bud-wood and graft-wood carefully. They are studying the question as to whether it is of germ or physiological origin. It may be something analogous to cancer—we can't say. They are working on the problem diligently at the Citrus Experiment Station. Also we are particularly interested in whether Sun-blotch is transmissible through the seed and rootstock. This question was particularly important when seed was very high-priced and people would pick up poor seed any place and every place. Undoubtedly much of that seed was from Sun-blotched trees. The Experiment Station is now studying rootstock planted from fine healthy trees and from Sun-blotched trees. It is my opinion that nurserymen generally must be more careful to exclude Mexican seedlings which may have come from Sun-blotched trees.

**Prof. Horne:** In addition to what Dr. Coit has told you, we have found seedling trees that have Sun-blotch. They did not get it from grafting or budding and so that is eliminated. Whether they got it from the seed or not, it is an interesting question. There

is another possibility—the disease may be transmitted in a manner similar to the trouble affecting sugar beets. These are bitten by a little leaf-hopper. It lights on the beet but three minutes. But if this little leaf-hopper happens to be infested with a certain disease, the beet never recovers. There is a cranberry disease that is transmitted in the same way. Only the cranberry plants do not die—they just get sick and stay as an encumbrance to the ground. I would advise all of you to bear this possibility in mind and if you saw any suspicious insect, to report it. At the present time we are using violet ray treatments to see if they will produce Sun-blotch. We tested them with the X-Ray and it didn't produce Sun-blotch. We are making some progress. But by all means do not propagate any trees from Sun-blotched stock.

February 16, 1931

**Question:** I should like to ask about a Mexican seedling tree I have. The fruit on it has a good flavor but gets a spot like a callous about an inch or an inch and a half on the bottom side. What would be the proper thing to do? It doesn't seem to spread to any other tree. Should we kill the tree for safety's sake?

**Dr. Horne:** The pathologist is stuck. We feel sure that these diseases on trees such as you mention are not due to parasites and we know at the present time the tree isn't necessarily dangerous to other trees around it.

**Dr. Coit:** Probably if that tree is a Mexican seedling, your fruit is getting over-ripe. Use it instead of letting it spoil on the tree.

### **Tip-Burn**

November 22, 1930

**Question:** What causes burning of the leaf-tips?

**Dr. Coit:** Usually it is brought about by lack of soil moisture and is contributed to and intensified by the presence of a high chlorine content, such as common salt, in the soil or irrigation water. In other words, I know of places where trees are tip-burned though they have perfectly good soil and good water due to a shortage of water. Other places where there is plenty of water will show severe cases of tip-burn because the irrigation water is highly alkaline. What to do about it is a question we have not yet settled to our own satisfaction. In a number of cases benefit has been derived from making basins around the trees and applying water suddenly in a large volume which apparently has a tendency to leach the salty material downwards. Near the Coast there are a number of complicated factors brought about by the ocean and the wind. A number of places near the ocean windbreaks have been erected to protect the trees from the infinitesimal particles of chlorine carried by the wind.

March 10, 1931

**Question:** I would like to ask what is it that causes leaf-burn, tip-burn? We have some of that on good soil.

**Mr. France:** There are a good many different things that cause it. One thing, when a tree gets too dry, you will find a lot of burning. If there is an excess of minerals in the



soil, you are going to have some burning. Why this tree burns and this one doesn't under identical conditions is the thing that makes it rather puzzling.

**Question:** Will that finally adjust itself?

**Mr. France:** There is one difference between plants and animals. Plants have no sewer system, as such. Age and maturity is tied up with an increasing amount of mineral matter in the plant tissue. A lot of things not needed remain in the limbs and leaves, such as sodium in the form of salt and lime accumulated in the leaves. The tree sheds the leaves and grows new ones to take their place. It is the only excretory system the plant has. The leaves reaching the end of their maturity have stored up a considerable amount of plant food. As soon as the leaves drop off, new leaves come on and apparently the tree is not severely injured unless it has had a very severe attack.

May 16, 1931

**Dr. Coit:** I might say here that I think the term, "Brown mite," should be used rather than "red spider." This will differentiate it from the common citrus red spider which is so similar in many ways and yet is an entirely different insect. People are liable to confuse the two—the citrus red spider and the avocado brown mite insect.

### "Kink-Neck"

November 22, 1930

**Question:** Why has the Spinks avocado a tendency to form a spot on one side of the neck and before it is half-grown the neck twists over and gets kinked. Finally the fruit falls. This is a very common and wide-spread trouble.

**Dr. Coit:** As you know the avocado is somewhat egg-shaped, that is higher on one side than the other. So far as I have observed, this deficiency in development in the Spinks and some other varieties comes on the high side of the fruit. It may not always be there but so far as I have been able to make out, that is what takes place. The high side instead of developing becomes depressed, growth is retarded at this one point, the little rough prominences instead of expanding remain as they are kinking the fruit. Finally the fruit drops off. It seems to be a case of retarded development but we do not know the cause.

### Dothiorella Rot

February 16, 1931

**Pathology:** The following letter from Dr. Wm. T. Home, Associate Professor of Plant Pathology, was read:

"Dear Mr. Hodgkin:

"Thank you very much for your letter of January 28.

"In addition to the reasons which you give, which would make it seem probable that the off-bloom fruit should logically be expected to be more subject to Dothiorella rot, the following might be added. Infection in all probability takes place from spores which are

formed in the dead twigs in the avocado tree itself. I think it hardly probable that ,-, these spores would be formed and expelled or given off by the fungus, except during wet weather; so that probably infection takes place during rainy periods or when the fruits and twigs are wet. Atmospheric humidity alone probably could not accomplish distribution of the spores. I have now observed the fungus in the spaces below the flecks in the rind of the Fuerte, and am endeavoring to find out more certainly whether this is the same fungus which we find in the fruits which are decaying. If it is, I think the picture seems to be fairly well outlined. However, perhaps it is as well not to count too much on this until the facts are more securely established.

"With regard to the control of moisture conditions as a measure of restraining Dothiorella rot, I think that I missed something in this regard and am glad that you are looking into the matter carefully. I tried out fruits under varying conditions of moisture from thoroughly wet to very dry here in the laboratory. This was done especially in connection with trying to get some understanding of the 'speckles.' While I have not carried on what could be called fully formalized experiments in this regard, I have made quite a number of tests and I get this impression: I have a feeling that it will be better for the fruit if it is not dried excessively up to about the time when it begins to break. After a time, just before the softening process becomes observable, I believe the fruit will in every way be better if it is kept in a thoroughly dry atmosphere. I am giving you this notion of mine for what it is worth and you will understand that I do not have data to back it up, but only the impressions which I have obtained from watching fruits of various sorts in our laboratory. I have had to acknowledge to myself that fruit which is so 'dry that it is withered and darkened on the surface may taste just as good as other fruit which has been ripened with less drying and has an attractive green color. The condition of the fruit offered on the stands after north winds have been blowing for a while in the fall seems to me anything but attractive, although perhaps the fruit is all right for use. I have had fruits in the laboratory dry in such a way that the Dothiorella rot showed only as a slightly softened layer below the surface and would have gone entirely unnoticed. These have been checked out by microscopic examination and cultures so that I feel sure I am not mistaken. However, I thought this fruit too unattractive for the best commercial purposes. I understand fully that some procedure which I might work out in the laboratory might not be practicable to employ in commercial operations; and anything I might find out would have to be tried out to see whether it works under the conditions of commercial operation.

"I appreciate very much your comments on 'kink side,' 'end spot,' and 'eye rot.' These are of exceptional use to me now when I am endeavoring to get the final draft of my bulletin in shape."

Dr. Horne was asked about the effect of overhead sprinkling.

**Dr. Horne:** Some of you have noticed when I have been approached as to whether overhead sprinkling might be detrimental to the trees, I have refused to agree, my idea being that we needed specific observations to determine this. I have stated it should be watched. Now the question assumes more importance than we have hitherto realized. Overhead sprinkling and its effects should be watched carefully. There is no question that where the trees are full of dead twigs, and any ordinary avocado tree has dead twigs, the wetter they are the more the fungus grow. However, even now after some

time devoted to studying these fungi, I am not ready to state positively that these fungi in the trees are the same as we find on the fruit and undoubtedly there are lots of troubles the fruit acquires after leaving the tree.

Now as regards these black spots. This matter is of importance. You can tear off a third of the surface and the rest of the fruit will be usable for this rot does not penetrate rapidly but if you want to sell the fruit, the outside is pretty much the whole story. This fruit is not going to be very salable, so commercially the matter is important.