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DISCUSSION

AVOCADO ROOTSTOCKS

Malo: We have a period of discussion now on avocado rootstocks. When it comes to avocado rootstocks, of course, we have to recognize that Dr. Zentmyer and his group in California and Dr. Gazit and his group in Israel are perhaps doing more than anyone else to obtain rootstocks that will be, first of all, tolerant or resistant to *Phytophthora cinnamomi* and also to soil salinity and iron deficiency. There are countries in Central America, like Costa Rica, that, due to their high rainfall and heavy soils, don't have any avocados at all. If Dr. Zentmyer finds an avocado tolerant to *Phytophthora*, there's going to be a lot of statues erected to him in little towns of Central America. There are a lot of people that don't have avocados to eat down there and the prices of available avocados are very high. I was talking to a colleague from Mexico this afternoon and he was telling me that last year's prices for 'Fuerte' and 'Hass' in some of the areas of Mexico were \$2.00 a kilo. This is mostly because of the high demand and low supply in some areas.

We have to recognize that the limiting factor in the production of the avocado throughout the world is *Phytophthora cinnamomi*. Until we find something to solve this problem, or at least to learn to live with it, we are going to have problems producing this fruit. Fortunately, in Florida we don't have this problem but it appears that if we extend to the sandy areas where the water table is high, we may have this problem. We have a unique situation here and we have been very lucky to adapt ourselves to it.

Another thing that I would like to mention at this point, because I will not have the podium after this, is the fact that this is a unique opportunity for us to know each other, to realize that the world is really small and that we all share a lot of problems. The jet age has shrunk the world, so we can share a lot of material, a lot of ideas, a lot of information. Because we are a small industry, we have to share the little information that we do generate. I don't think there is any problem with competing in similar markets. The demand for avocados is going to increase throughout the world, I'm certain of this, as more people get to know the avocado—the world population is expanding. Since we are a small industry of research, extension and growers, we have to share ideas and information.

So let me open this period of discussion by asking a question of Dr. Zentmyer. I'm sure that this question is in the minds of every one of us here. You have been collecting a fantastic amount of germplasm. Is it possible to share some of this germplasm in the future? I'm sure I can contribute some if I know in which ways I can contribute and I'm sure that some of us in different areas would like to send seeds or materials of different types to this program, but at the same time we would like to get some advantages, if there are some in the future.

Zentmyer: I don't have any really direct answer for that right now, though I'm sure we can work out arrangements for cooperation in exchanging materials. We've done a little of this to some extent, but it hasn't been done as much as it probably could be or should be in the future. Florida, through Bob McMillan, has made some beginnings in relation to collecting, especially with some emphasis on the lowland West Indian types. So we've talked about some exchanging of materials with Florida, so I'm sure we could work out some arrangements. Just what the mechanism would be, how best to arrange it, I haven't thought about at the moment. I certainly agree with you that there should be a sort of worldwide effort because there are problems common throughout the world and there are countries where they are not growing avocados very much. Costa Rica is growing some, for example, but they could grow so many more if they did have even some tolerant or moderately resistant rootstocks.

One thing we don't know in that regard—we have not tested some of our rootstocks against different strains or races of *Phytophthora cinnamomi*. We are getting a little evidence that there are, like with other *Phytophthoras*, possible races of this fungus. So there is a possibility that maybe some of the strains and races in South Africa might attack our 'Duke' more readily. There is some of our 'Duke' material in Australia, but they haven't gotten, as far as I know, any material out in the field yet for testing under their conditions and with their possibly different types of fungus isolates.

Knight: It was most interesting to see the resistant lines of 'Duke' and the other lines that showed quite a bit of comparative field resistance. Has there been an effort to, crossbreed these outstanding ones and then see what kind of progenies you get and what responses to *Phytophthora*?

Bergh: Dr. Knight is referring to materials that Dr. Zentmyer is assembling, among which there are 5 and perhaps more major lines, each of which shows some resistance and none of which alone shows enough resistance to be a commercial solution. At Riverside we are working on this now. These different lines come from all over the place and presumably, hopefully, have a different genetic basis for resistance.

Let's say that we need a commercial level of 10 resistance units, whatever that is, to have a commercial solution to the root rot problem, and that each of these 5 lines has maybe 5 units. Each line works in borderline cases of *Phytophthora*, but when things get rough, they go down with root rot. What I've done is to graft these lines in pairs, all 5 of them, making 10 different pairs and then to cause hybridization, If the resistance is dominant, genetically speaking, then in the F_1 lines we will in fact get our 10 units and will have our commercial solution. I'm afraid we're doing a little wishful thinking here. Resistance is probably partly recessive, so we will have to go to an F_2 . You put your finger right on the problem, Dr. Knight, and one we can go at trying to get to a solution.

Malo: Regarding the situation that Dr. Zentmyer posed concerning different strains of *P. cinnamomi*, I'm sure that you would like to receive samples of roots from different areas of the world. Is there any way that people in different countries or areas could be more selective as to what they send you to avoid flooding you with thousands of diseased samples?

Zentmyer: On the aspect of more virulent types of fungus, we can and we are making a beginning at this testing, without too much problem, in our own greenhouses, laboratories and so forth. In fact, I already have over 300 isolates of *P. cinnamomi* from just about all the countries where we have the problem—South Africa, Australia, Hawaii, Central and South America, Mexico and the Canary Islands fairly recently. So we have a nucleus, but we are just really starting to get into this matter. We have been trying to work out a fairly simple test, which we haven't quite solidified yet, but I think this can be done pretty easily so as to compare an isolate from California with several from Mexico.

For instance, because of some problems in California, we have some really very good information now on the isolate of *P. cinnamomi* which attacks camellias. You may know, I don't think I mentioned it this morning, but we've been comparing pathogenicity and soil infestation experiments and stem inoculation experiments of the camellia isolate vs. the avocado isolate—inoculating avocados with the camellia isolates and camellia with avocado isolates. We find that the camellia isolates are generally pathogenic to avocado. The camellia isolate is the other mating type of *P. cinnamomi*, the A mating type. These are quite virulent on avocado and of course on their own camellia host. The avocado isolates, on the other hand, are pathogenic to avocados but not to camellia. So we have an indication of race differences there, but unfortunately in the wrong direction. We would rather the camellia isolates were not pathogenic to avocado because then you might avoid some of these infestations which can get into the grove from ornamental plantings around a house, for instance. With that little experiment we were hoping that some of these ornamental plant isolates, beginning with the camellia isolate, would not attack the avocado, but unfortunately they do. We were trying to do that not just with other hosts attacked by the avocado isolates but with other avocado isolates for relative virulence.

Malo: It seems to me that there are 2 things to this problem then. First of all, the looking for avocado types, avocado relatives, different species that may cross-graft with avocados tolerant to *Phytophthora* and also studying all kinds of races and strains of the fungus itself. If you have any outstanding observations, if you have anything that looks unusual, you may like to communicate with Dr. Zentmyer, as I am sure he will be willing to communicate with you.

Galan: Do you think that most genes for resistance are located in Mexican or Guatemalan races or can there also be some resistance in West Indian types?

Zentmyer: So far, we found more resistance in the Mexicans and our selections from various Mexican types. For instance, 'Duke' is a good Mexican. The new 'G6' which I showed a picture of this morning is a Mexican type, typical anise-odored, small, black-fruited. Those are just a couple of examples. We have a few Guatemalans that have shown some encouragement. One I call 'G22', which I got a number of years ago between Guatemala City and Coban, shows moderate resistance. 'G22' is, unfortunately, an extremely variable one that we can't figure out. It looks excellent in some of our field plots and miserable in some others. So we do have maybe a couple of Guatemalans that show some encouragement.

We haven't tested recently as many West Indians as I did in the first years of the

project. What I consider and Wilson Popenoe considered one of the progenitors of the West Indian race, the wild avocado of Golfo Dulce which Paul Allen thinks is a primitive West Indian, is a small West Indian fruit, very thin skinned, otherwise typical yellowish-green West Indian, but with a huge seed. I collected a number of seed of that thing, in 1962 or something like that, and it is extremely susceptible. I have tested quite a few West Indians with, I think, probably a little less indication of resistance there. There is always a chance that they may have some, considering the terrific variability you can get in the avocado. There might be some chance seedling, some chance collection somewhere that would have better resistance than the West Indians we've tested, so far we just haven't seen as much as in the Mexican and a few of the Guatemalan types.

Campbell: Dr. Robert Conover at our center is working on a fairly large project with papaya, looking for plants that are tolerant to a severe virus. In this project he set up a tissue culture lab and brought a post-doc, Dr. Richard Litz, from England to try to vegetatively propagate papaya strains which are resistant to viruses. Now, money is not inexhaustible, so they are looking for grant money to work on other tropical crops. Avocado is one of them and Bob Platt made the statement that Dr. Murashige, who I suppose is the dean of this whole business, has found the avocado to be extremely intractable in culturing to make large numbers of plants. Has this been a pretty broad survey of avocado types? Does Murashige feel that it's not worth pursuing avidly or do you have any comments in general on that?

Platt: I was just conferring with Dr. Bergh on that, as he has been working with Dr. Murashige on some of this work. In preparation for the discussion this morning on clonal propagation, I talked to Dr. Murashige and he indicated that there were difficulties that he had encountered in trying to use the tissue culture techniques which have been successful with many other plants. These had worked beautifully with citrus, many ornamentals and with some of the vegetable crops, but avocado is stubborn. His comment was that they are looking now at some of the basics and trying to find out why avocados are so stubborn regarding tissue culture.

I might add that he has worked with Dr. Bergh in irradiation of some avocado material to try to break down the barrier of incompatibility between those relatives that are immune or extremely tolerant to *Phytophthora* but non-compatible with *Persea americana*, or through radiation, introduce a tolerant factor into those that are compatible with our commercial varieties. So this is another avenue of approach to the problem.

Gazit: I would like to add that in our laboratory in Israel we have worked for the past 5 years on the same problem. Until now, we cannot declare any success, but in the last few months our preliminary signs are that we may be able to use the tissue culture technique for avocado propagation. It is a little bit too early, but we are hopeful. In 2 labs they are getting good first results. We probably worked with entirely different cultivars, as we are much more interested in cultivars that have West Indian blood in them. They seem more difficult to propagate and we are hopeful.

Ramirez: Everybody is worried about *Phytophthora*, but I'm worried about alternate bearing also. Is there an attempt right now to determine from the physiology of the

tree what factors are influenced by the rootstock? Which factors are the rootstocks regulating and which factors are the scions regulating? Once we have the answers to *Phytophthora* resistance, we still have to determine other effects of rootstock/scion combinations.

Malo: This goes back to the comment that Don Gustafson had this morning in which they had located one particular combination of 'Fuerte' and stock X which was outstanding, but the same scion on other seedling stocks did not come near to the production of the parent material. You are always directed to different areas where they say there is an outstanding tree that produces crops every year. I was in Pomona, California, 7-8 years ago and they told me they had an outstanding 'Fuerte'. I got some budwood and brought it to Florida, but this outstanding 'Fuerte' turned out to be just plain 'Fuerte'.

Barnum: In your talk this morning you mentioned the use of Truban® for *Phytophthora* control. Is there a possibility that Banrot® would be as effective for control or have you worked with it?

Zentmyer: We really haven't tested the Banrot® formulation yet. The formulation we've tested most is Terrazole®, which is similar chemically to Truban®. It's a little different formulation of the same chemical ethazol compound. Both of these compounds are more specific for the Phycomycetes, especially for *Phytophthora* and *Pythium*. As I recall some of the statements on Banrot®, I don't think it has this type of specificity, but we haven't tested it.

Many people have asked me about things like Benlate® and some of the new spectacular fungicides you hear about. We've tested it and other people have, but it is very definitely not effective on *Phytophthora*. Most of the newer fungicides, unfortunately, are not *Phytophthora*-active. There are a few exceptions like Terrazole® and Truban®.

Dow had a new one called Pyroxychlor® which is a very specific material for the *Phytophthora* group and which was looking excellent in some of our early trials. Unfortunately, they ran into some trouble. They came up with a metabolite of it which was apparently carcinogenic. The FDA and EPA are very careful, and they should be on this type of material, so some of these materials are going to be out of the running because of other types of toxicity.

There are these 3 or 4 examples of special types for *Phytophthora*—Pyroxychlor®, Truban®, Terrazole® and a couple of new Ciba-Geigy things which just have numbers yet but are really very encouraging. We hope to have more information on those this next winter.

Barnum: Do you foresee when the application of these particular fungicides through a drip irrigation system will give enough lateral translocation in the soil to get good control of this problem?

Zentmyer: This is a thing we are certainly interested in and some of the chemical companies are. We're starting some work along this line. Some of them are mostly water soluble and 2 of these new Ciba-Geigy things are very interesting from that standpoint. One of them has 7,000 ppm water solubility, for instance. I think this type

of tiling could be very well applied in drip systems. We've tried a little of this with Terrazole® in a couple of plots in California. We had a lot of trouble with one of them as it's quite corrosive to metal linings, metal fittings and so forth. So we've had some problems getting the material on as often as we wished, but this is an interesting approach and we're sorry we don't have enough information to say that this will work. I think it has very good possibilities, especially in young trees.

We have several plots using Terrazole® and Truban® in granular form. We're spreading a small amount of the material around young trees, and in some cases around larger trees, and letting water, whether it's a drip system or whatever, carry this granular material in, treating maybe once every 2-3 weeks or occasionally once every couple of months. So I think there are some good possibilities using drip irrigation to carry the materials down at least to where most of the roots would be.

Valenzuela: I wonder if someone has observed or measured an outstanding selection growing on its own roots. Would a scion which is rooted as a cutting produce better than it would produce when grafted onto seedling rootstocks of any kind?

Malo: We have hundreds and thousands of trees of 'Waldin' on 'Waldin'.

Valenzuela: I'm referring to rooted cuttings of a scion variety compared to that same scion grafted onto seedling rootstocks.

Goldweber: This has been done with 2 varieties, 'Hass' and 'Fuerte', but it made no difference. You would have to do it with each and every variety in order to determine if it would do better on its own root system than it does on seedling root systems.

Gustafson: There was part of a rootstock plot started in the early 1950's where we used cuttings and budlings of 'Fuerte' and 'Hass' grafted onto 'Fuerte' and 'Hass'. I don't think there was any attempt to pick out any particularly high-producing budwood for the scion. This was kept for about 17-20 years and the only thing that we actually saw that was significant was that the trees were more uniform in their growth habit. There was no particular difference in production. We checked it every year compared to the ones that were on a multiple type of seedling selection in those test plots, but nothing really came out of it and nothing else has been done beyond this because there was nothing significant indicating that there was any advantage in doing it this way. We had West Indian, Guatemalan and Mexican rootstocks of variant types in different counties in the state, but all of those were seedlings. Two rows were the only ones on cuttings. Bob, do you want to add to that because you have all the records from our studies?

Bergh: 'Bacon' does the same thing. It's a little more uniform on its own roots, but yield is not affected one way or the other.

Gustafson: I don't think we have a pure rootstock cultivar as a clone. I think in any of our propagation materials we are getting some type of influence from a rootstock or a nurse branch or a stock and I would like to know what is this influence, of what type of a chemical. Is it a hormone? Is it an enzyme?

Dr. Zentmyer has found through chemical analysis that there is a certain chemical element in the resistant rootstocks that he has introduced from Central and South

America and this particular chemical isn't in the susceptible rootstocks. I'd like to see some plant physiologist take hold and see what is this thing that passes between the rootstock and the scion and the scion and the rootstock.

We know in citrus that various rootstocks have different influences on the top of the tree and I can't help but feel that this same thing is going on in avocados. But I don't think anybody has ever taken hold and found out what this particular reaction is and I think until we find that out we are just going to be beating our heads with the thousands and thousands of selections of seedlings that are all open pollinated or until we find a new technique where we can get a pure cutting. However, you take a cutting off a tree of a certain rootstock and scion combination, you're never going to be able to duplicate that thing unless you find out what this scion is and what the rootstock is and the influence that goes on between the 2 of them. I leave that with you.

Malo: For those of you that perhaps don't know or ignore the fact, each avocado in an orchard is grafted on a different seedling so each root is different, thus each tree is going to be a different individual. In avocados we don't have the advantage that exists in citrus and mango, which have polyembryonic or nucellar stocks. We don't have that fortune in avocado work. Each seedling is different and subject to genetic segregation.

Balerdi: If there were an area of *Phytophthora* infestation and you treat the field with methyl bromide, would it be safe to replant that field to avocados?

Zentmyer: This is a whole basic matter of how useful fumigants are in replanting avocados. I've maintained for a long time that fumigants are only effective where you are trying to eliminate or treat a very small area of infection. If you have several acres or maybe even 20, 30 or 40 diseased trees, it's really impossible to actually eradicate the fungus. You can knock it down to a very low level with methyl bromide or with other fumigants that we know. Then you can get successful growth of replants for 2, 3 or, if you're lucky, maybe 4 years and the infestation that you could not completely eliminate will come back in and you will have the same soil situation that you had when you first started to fumigate.

So I think I of the useful aspects of fumigation is where you catch the disease in the very early stages, where you bring in the nursery trees and you find out that there is infection within the first, hopefully, few months. If the roots have not grown out more than a few dekameters beyond the original ball, fumigation has a very excellent chance of really eliminating the fungus.

Maybe a combination of types of treatments will be effective— combining what resistance we have with fumigation, with treatment, with fungicides and with biological control. We are sort of shifting emphasis away from the fungus and to the plant, so fumigation may have some benefits beyond the original couple of years which we know about now.

Fuertes: Why is it that Dexon® is not used or allowed to be used on avocados for *Phytophthora* control?

Zentmyer: Dexon® was approved for use on avocados about 12 years ago. We got

all the residue data necessary at that time from our chemists and Chemagro, which was producing the material. It was approved and used and quite a few of the California growers at least tried it. It wasn't a tremendous success but it did give some good results in a number of field plot situations. Then FDA changed the residue regulations and did away with the "no residue" tolerance, and made the companies establish the finite residue, like maybe even 1 ppb or 10 ppb. At that time, Chemagro, which was the principal manufacturer of Dexon® did not feel that it was worthwhile going back into it. They would, have had to redo some of the residue and toxicity data and put quite a little more money into the project. That's all the reason I know, but there may have been some other problems with the chemical. We've heard rumors of other aspects of toxicity but the main reason was this change in regulations.

Hannon: You have just glossed over the nematode problem. You mentioned briefly the reniform nematode. What about some of the other nematodes affecting avocados, such as *Radopholus* or *Pratylenchus* and some of the others? They lost quite a few avocados in the Lake Placid area due to burrowing nematode.

Malo: Dr. Hannon is a nematologist from way back so he is concerned about nematodes, as Seymour had mentioned finding the reniform nematode over here in Homestead. Is there any other finding of nematodes in avocados in other areas? We would like to know this because it's a very important subject. No reaction from the audience. Apparently, there's no problem with nematodes outside our area. Dr. T. W. Young did some work with *Radopholus similes*, which is the spreading decline nematode of citrus.

Goldweber: We had periodically, annually as a matter of fact, been sending root samples to the nematology laboratory in Gainesville on all of our tropical fruits and, I think it was 2 years ago, we found trees that were showing what appeared to be serious water stress and we suspected perhaps *Phytophthora*, but to back ourselves up, to hedge a little bit, we sent samples to the nematology laboratory and they came back with reniform and the trees were in a decline. Young trees. Shortly thereafter, oddly enough, trees that had shown no decline, trees up to about 4 years of age, were showing the same kinds of symptoms and we were picking it up again. However, without any treatment, the trees have started to show a recovery. This may be attributable to situations analogous to our *Phytophthora* problems where we get enough aeration and where, if the stress isn't water stress, the trees will put out roots and start to recover.

We believe that with management of weeds, especially certain types of grasses, we may get away from having this nematode problem. Oddly enough, in most of these cases we were practicing clean cultivation, wiping out these weeds, mainly with paraquat. The nematode problem increased on avocados, but the avocados did grow back out of it. We did not plant the weeds again but the avocados did make it back. We have found *Pratylenchus* and other nematodes but never in a population of sufficient density to warrant any treatment. In fact, we're very happy about this because we don't have any treatment anyway.

Galan: I would like to ask Dr. Bergh that since it looks like cross-pollination has some effect on production, whether he tries to test the cross-pollination effect in new

cultivars that he is developing in his breeding program.

Bergh: I think, Victor, there are just too many uncertainties on this yet. Take 'Fuerte', for example. If we were selecting that now, we would discard it for lack of enough fruitfulness. Yet, as a result of cross-pollination in one particular year we got the equivalent of over 34,000 kg/ha on cross-pollinated 'Fuerte' trees. There are just too many uncertainties here and at the present we do not have the refined techniques for picking out what is going to work and how well it's going to work in the future. So all we do is look at them, at how well they are setting, regardless of why they're setting, then we will get them out and get a better look at them and decide there.

Krome: As you know we have the problem here with hurricanes, and in spite of my pleadings you have never developed a rootstock with a ball and socket joint. Is there any evidence anywhere that you can get rootstocks that may make the trees a little smaller?

Gazit: We have some evidence of this in Israel. It may be connected to the fact that Israel is a subtropical country and the climate, the soil, may be too cool, so I wouldn't rely on it. We don't have the 'Waldin' in Israel, we imported it only a few years ago. We didn't get seeds until now, so all our West Indians are not the same as you are using here in Florida. We are using what we call the 'Nahlat' type. I don't know if somebody here from Florida can compare them. So maybe the 'Nahlat' will make the trees a little bit smaller, but the effect is not appreciable.

Mendoza: I believe that there is a normal dwarfing effect in grafted trees. Normally, a seedling in tropical Venezuela may grow to 25-28 m in altitude. When the seeds of such plants are used as rootstocks for the native varieties there or for improved varieties, the resulting grafted trees of 10-15 years of age only reach about 12 m in height at their tallest. So there is a dwarfing effect.

Malo: Many years ago Dr. Bergh published in the Avocado Yearbook about a dwarf Mexican that they had in California, the 'MT-4', and I immediately wrote a letter to him asking for some budwood. Well, we grafted it here in Florida but though it hasn't turned out to be a giant tree, it is a medium-sized, vigorous tree here. So I don't know how dwarf it is in California, but in Florida, it's a very vigorous plant. You will see it Wednesday.

Bergh: I have encountered a number of humiliations in my life and maybe I should have slipped Simon a couple of bucks to keep quiet about that. It's sort of an interesting story all in itself. We wanted to test this possible dwarfing rootstock. It had some of the characteristics of dwarfs in other fruit plants. We wanted to get replications, so we took the embryo and cut it into several parts. You can do that in the avocado, maybe you never tried it, but it works, and get each one to grow. You can get up to 7 or 8 genetically identical trees from each sectioned embryo. And then we let them grow up until they were graftable size and we grafted them. When we planted them out in the field, here we had these little trees, some of them very small, with 20-30 fruits on them. It was sensational. I took all kinds of parties around. "Look at my dwarfs and what a tremendous thing I have here."

Then we went back to normal seeds to show how effective this could be on a large

scale and the effects were gone. This is after I had gotten the letter from Simon and I didn't know this at the time. The sectioning caused a delay in the growth of these stalks so that by the time they were grafted, there had already been physiological changes such that the top was completely changed. So we had these tiny little Christmas trees just loaded with fruits hanging all over them—most beautiful sight you ever saw—absolutely useless for dwarfing avocados.

Malo: This cultivar is really short-internoded and it reminds me of some of the short-internode types, West Indian types. We have here in the Homestead area several types that look dwarf but we don't have any assurance that they would have a dwarfing effect. We have been testing them as interstocks. There is one type that apparently came from Atlixco many years ago called 'Nehualzalcoyotl'. It's an impossible name to pronounce but it is a dwarfing Mexican.

We have another type which is very common here in Florida. It's a dwarf 'Lula' which makes a beautiful ornamental plant. It doesn't bear very well and the fruit looks misshapen. It drops its fruit and so far I consider it just a beautiful ornamental plant. It is really. You'll see it Wednesday.

So there are dwarf types in other areas and perhaps we can exchange material and we can have a germ plasm pool of dwarf plants.

Hannon: From the discussion the other day, I understood that sun-blotch is transmitted by grafting. Is there any evidence that sun-blotch is mechanically transmitted?

Malo: I wonder if there is somebody from California or Israel who can comment on this? We don't have that much of a problem with sun-blotch, although we do have it and it is increasing.

Platt: So far, the only evidence indicates transmission by natural root grafts and budwood or propagating material or through seed.

Hannon: You mean to say that it is definitely seed transmitted?

Platt: Yes, it is.

Dawes: Just a comment on what Dr. Gazit said about the dwarfing influence of West Indian stocks. It's fairly obvious this must be quite a complex question because I have seen a trial at Alstonville in northern New South Wales. This is the New South Wales Department of Agriculture Tropical Research Station where they had a trial with 'Fuerte' on West Indian seedlings against Mexican seedlings and that was originally laid down to see if there were differences in resistance to *Phytophthora*. They didn't get *Phytophthora* in this trial but 'Fuerte' on Mexican seedlings were considerably smaller trees than on West Indians.

Gazit: These are entirely different soils, and those soils may be more suitable for West Indians, which may be the reason. Climates also are different.

Dawes: Well, I find it a bit difficult to comment on that except to say that I think it was trickle irrigated. It would be supplementary irrigation and probably in an area that was less suitable in some ways for West Indians. So I don't know. You answer that. I'm just trying to point out that there must be a lot of complicating factors in this.

Gazit: I would like to emphasize that when we are speaking about the West Indian race or the Mexican race, we are speaking of a very large group of very variable types. In other words, what we have seen is a certain population of a certain definite group of West Indians. I hope that in the coming years, the work of Ben-Ya'acov where he compares the performance of about 250 different rootstocks, or more exactly, rootstock populations, will give us a more comprehensive answer. He tried to measure everything, including the size of the trees, using photography by planes to do it. These results are very, very limited, which means that, in some cases, we have seen clearly that plants were smaller on West Indian rootstocks but it may be a local reaction to certain conditions. That's all.

Gustafson: During the last 3-5 years our industry in San Diego County, as well as the Ventura area, Santa Barbara and part of Riverside County, has experienced a tremendous planting boom. We've planted thousands and thousands of trees. About 3 years ago, the nurserymen were very hard put for rootstock seeds. There was an importation of 'Waldin' and 'Lula' seeds from Florida and these were given to the nurserymen. One nurseryman used quite a bit of the 'Waldin' and this year it has come back to haunt him. He's had to replace thousands of trees because the 'Waldin' trees grafted to 'Hass' or any other variety, (most of them were 'Hass') refused to grow once they got in the field.

In investigating many of the groves, there may have been some adverse conditions where the growers were hard put to get the trees in. They may have let the trees get a little dry. Also, in some areas it might have been too cold. When we made a tour of the various orchards, we definitely saw that "Waldin" was the tree that was being mostly affected. The trees just sit there and don't do a thing. They lose all their leaves and twigs die back and go black.

So he is replacing thousands of these trees and he will not use 'Waldin' in California. Now it may be cold, it may be lack of moisture, it might be that these trees cannot take the adverse conditions that some of our other trees can take. No problem with 'Lula', but in this case the pure West Indian has given us this problem. And this is a very practical problem and the nurserymen really took a lacing as far as cost in the use of these in this situation to get trees out to the growers that were demanding the trees.

Colburn: What were the results with 'Lula'?

Gustafson: As far as we could tell, there has been no problem with 'Lula'. The nurserymen seemed to like it. It is a large seed, it grows well, it grafts well and to this date we have nothing adverse. The thing that we're concerned about, and I'm sure it's in the back of the mind of every nurseryman and grower that used it is this: how many sun-blotch 'Lula' seeds did you send us from Florida?

Krome: Aside from their resistance to *Phytophthora*, have any of the other species of *Persea* that you have budded to avocados shown any suitability at all as rootstocks for avocados, or have you tried them except to determine their resistance to *Phytophthora*?

Zentmyer: I really haven't done much of that. Bob Bergh may want to comment on

this. We've just determined whether a lot of these different species were at all compatible in the first place. We know for instance that *P. schiedeana* is somewhat graft-compatible with *P. americana*. You can graft 'Fuerte' or 'Hass' on *P. schiedeana* rootstock, but it varies quite a lot with the *P. schiedeana* collection source. The first *P. schiedeana* I ever saw grafted were to 'Fuerte' in Honduras by Wilson Popenoe. These were growing very poorly. The stock had overgrown the scion and the tops were growing very poorly.

I have had other reports and I think Art Schroeder has, but I've forgotten the source of his *P. schiedeana* materials. Art sent some *P. schiedeana* to South Africa, so maybe someone from there would know something about this. They were apparently growing fairly well. J. C, do you want to comment on *P. schiedeana* as a rootstock in South Africa?

Toerien: They have been tested but the grower is pulling them out. He had 'Fuerte' grafted onto *P. schiedeana*. The results of this are published in the *California Avocado Society Yearbook*.

Zentmyer: So, here is another example of *P. schiedeana* apparently serving as a fair rootstock in South Africa. I'm not sure Art ever identified the source though, whether these seeds originally come from Guatemala, Costa Rica, Mexico or where. This is just a little more about *P. schiedeana*, that it can serve in some cases as a productive rootstock.

We've never seen much indication in relation to resistance of *P. schiedeana* to *Phytophthora*. I have a very interesting collection now from Guatemala, which looks like a hybrid between *P. schiedeana* and *P. americana*. We're just testing it in the greenhouse and it shows some very interesting-looking resistance. The seed is a typical *P. schiedeana*, elongated, from a large fruit, and the seedlings look more like *P. americana*. The leaves are not like *P. schiedeana* at all, though they are a little more rough and coarse than the typical *P. americana* seed. So this is an indication of some resistance in the *P. schiedeana* group.

Regarding other compatible species, we've had *P. floccosa* which can be grafted with *P. americana*. *Persea nubigena* also can be. We just recently got some *P. steyermarkii* that we're just testing. We're not sure about that one yet. Of the ones that we know are compatible, we just don't have much information on their usefulness as a rootstock beyond this little information on *P. schiedeana*.

Bergh: I might just add to Mr. Krome's question that in California, I don't think this is so different from the rest of the avocado world, pretty well any seed that grows would make a pretty good rootstock and our conditions have-been so primitive there that we don't know if one position or situation is better than any other. There are moderate differences with regard to salts and chlorosis but the 5 major lines that Dr. Zentmyer has found, I dare say, are pretty well as good as anything else we have. We have no reason to think otherwise. *P. schiedeana* and *P. nubigena* are botanically more removed, so there could be problems there. I expect not to find any better or worse.

Krome: I still would like to suggest that a further investigation of the other *Perseas* for avocado rootstocks is a suitable field for investigation.

Malo: I could also say that we have grafted *P. schiedeana* on 'Waldin' stock at the station and there is a perfect union, a very good union. So we've not found any difference really. We do have problems, for example, with Mexican types on West Indian types and the West Indian type as a rootstock overgrows the scion.

Gustafson: One comment to George. A friend that was in one of my pictures from Cameroon has found a West Indian-Guatemalan cross as a rootstock that they have found to be resistant to *Phytophthora*. He wants to know whether you would like some importation of seeds or scion wood from there.

Also, they have been using DPX-3217, a systemic which is a DuPont material. They want to know whether you have tested it?

Zentmyer: The DuPont material that's their fairly recent thing they've claimed as a systemic? DPX? Yes, we've tested it in Riverside, as we got it last winter sometime. In our tests, at least, it looks very poor on *Phytophthora*. We've no evidence of either reducing root rot or of any systemic actions. It's been pretty ineffective in our usual greenhouse screening test and lab tests. I showed pictures this morning of that Dexon-type test and it really hasn't looked at all good. Sorry about that.