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THE SEARCH FOR RESISTANT ROOTSTOCKS IN LATIN AMERICA

George A. Zentmyer
Plant Pathologist, Citrus Experiment Station, University of California, Riverside.

In May, June, and July 1956 a trip was made to Central and South America and the West Indies for the following purposes:

1) To make collections of avocado varieties and related species of **Persea** for use in our program of developing resistance to Phytophthora root rot of avocado. This was the primary purpose of the trip, with emphasis on materials growing in wet locations, and in the presence of the avocado root rot fungus, **Phytophthora cinnamomi**.
2) To establish contacts with scientists in countries not previously visited, so that they would be aware of the need for resistant rootstock materials and would send additional collections in cases where seed were not mature or where collections could not be made on the current trip.
3) To become familiar with the avocado disease situation in the various countries, so as to be aware of any potential hazards to the avocado industry of southern California, and to become cognizant of any developments in control of diseases that are present in California.
4) To evaluate and plan possible continuation of the cooperative avocado root rot project in Guatemala financed by the California Avocado Society.

The trip involved the period from May 2 to August 2, 1956, and included stops in Mexico, Guatemala, El Salvador, Honduras, Costa Rica, Panama, Colombia, Ecuador, Peru, Chile, Argentina, Brazil, Venezuela, Trinidad, Puerto Rico, and Cuba. Mr. H. W. Montgomery accompanied the writer during most of the South American portion of the trip.

MEXICO

No collections were made in Mexico on this trip, though arrangements were made with scientists with the U.S. Department of Agriculture Fruit Insects Section to send seed in the future. Two regions were visited to identify avocado diseases reported to be possibly new, an area near Queretaro, and another near the village of Jungapeo. **Phytophthora cinnamomi** was isolated from roots cultured from these regions, and the disease was identified as avocado root rot.

GUATEMALA

With Dr. F. J. LeBeau at the Servicio Cooperative Interamericano de Agricultura in

Guatemala City the cooperative root rot resistance project was evaluated, results to date were studied, and plans made for future collections and testing. Much of the new greenhouse space at the laboratory is taken up with the avocado collections made recently, and a number of test beds are in operation on the grounds of the institution. From this program a number of promising collections have been shipped to Riverside, and additional material that shows resistance in the preliminary tests in Guatemala City will be sent to us.

EL SALVADOR

Two collections of **Persea americana** types were made with the assistance of Dr. Richard Hamilton, horticulturist from the University of Hawaii, at present on a U.S.O.M. mission in El Salvador. Arrangements were made for Dr. Hamilton to send other materials in as they became mature.

HONDURAS

Several days were spent with Dr. Wilson Popenoe at the Escuela Agricola Panamericana, excellent agricultural school sponsored by the United Fruit Company. Dr. Popenoe, director of the school, was extremely helpful in providing information on locations to visit and contacts in South America, as well as furnishing valuable information on the avocado plantings and the disease situation at the Escuela Agricola Panamericana.

All of the older avocado plantings at the school are dying out with avocado root rot. There are interesting indications of an influence of the scion on response of the rootstock to the disease. **Phytophthora cinnamomi** was isolated from several trees in the older plantings, as well as from several trees in the nursery.

In the planting maintained by the school on Mt. Uyuca a virulent new canker disease was found on some of the Mexican race avocados; cultures showed this to be caused by a species of **Phytophthora**, probably **P. palmivora**. It causes extensive die-back of branches, with black discoloration in the bark and occasionally in the wood. A leaf spot disease was also found on the Mexican types on Mt. Uyuca. It was noted that avocados budded on **Persea schiedeana** rootstock were making very poor growth; the rootstock is noticeably smaller in diameter than the scion, and tops are stunted.

COSTA RICA

With Dr. Louis Williams, botanist from the Escuela Agricola Panamericana, and Sr. Don Otono Jimenez, friend and companion of Dr. Popenoe on early trips to Costa Rica, an attempt was made to find the "wild avocado of San Isidro." This tree was not found, but specimens were found later in the summer by Dr. Ralph Segall, plant pathologist in the S.T.I.C.A. office in San Jose, and seed shipped to Riverside. Another native tree was found in the course of this trip, in the San Isidro area, and budwood was collected. It is probably a **Persea americana** type.

COLOMBIA

Three collections were made of **Persea americana** types in Colombia on this trip, and three additional collections have been sent in by scientists contacted during the visit to Colombia. These include **P. chrysophylla** and two other **P. americana** types. Trips in Colombia were arranged by the courtesy of Dr. L. M. Roberts, Director of the Rockefeller Foundation Agricultural Program in that country.

Several large, apparently native, **Persea americana** trees were found in the hills near the town of Fusagasuga, on the lower edge of the rain forest southwest of Bogota. This is the farthest south that wild trees of the **P. americana** type were found on this trip; this appeared to be a West Indian type. No **Phytophthora cinnamomi** was found in cultures from trees in Colombia.

ECUADOR

Dr. Harold Yust, Chief of Specialists with the Servicio Cooperative de Agricultura in Quito, was very helpful in providing transportation and arranging facilities for the work in Ecuador, as was also Mr. Al Chable, Horticulturist with the S.C.I.A.

Nine collections of **Persea americana** types were made in different sections of Ecuador; many of these were Mexican types which must have come to Ecuador many years ago. Several diseases were identified, primarily in the Guillabamba Valley where there are thousands of seedling avocados. The diseases found in this valley were: Verticillium wilt, **Dothiorella** canker (caused by the fungus **Botryosphaeria ribis**, with the imperfect stage **Dothiorella**), and Armillaria root rot. **Dothiorella** canker in this region is different from that in California in that it affects Mexican seedlings, and causes roughened, black areas of bark varying in length from a few inches to a foot or more, usually extending completely around the branch or trunk. These cankers are largely superficial.

PERU

Seven collections were made in Peru, consisting of representatives of **Persea americana**, **Persea durifolia**, and several species of **Ocotea**, a genus of plants related to the avocado genus. One of the most interesting was the **P. durifolia** collection, made from a tree growing on the hillside above the old Inca ruins at Macchu Picchu. The tree had much the appearance of an avocado, but with fruit from ½ to ¾ inch in diameter, turning purplish black when mature. This fruit is larger than that of many of the small-fruited species of **Persea**, and it is possible that this species may be more closely related to the avocado than some of the other wild species.

Many people were very helpful with the collections and laboratory work in Peru, particularly Dr. Bazan de Segura, plant pathologist at the Estacion Experimental Agricola at La Molina; Dr. Ramon Ferreyra, Botanist at the Universidad Nacional in Lima; Ing. Carlos Bohl, Fruiticulturist at the S.C.I.A. in Lima, and Ing. Carlos Faura, pathologist with the Ministerio de Agricultura in the Chanchamayo Valley.

Several additional collections have been sent in from Peru during recent months by Dr.

Cesar Vargas C., Botanist at the Universidad de Cuzco.

Phytophthora root rot was found in the Chanchamayo Valley in Peru, as was Phytophthora canker. **P. cinnamomi** was isolated from specimens collected with Ing. Faura. The virus disease sun blotch was also found in the Chanchamayo Valley, on the Hacienda Pampa Americana. Sun blotch occurred on only one tree; budwood from which this tree was grafted at one time had come from the experimental planting at La Molina, so the virus could have come from this source, which includes several California varieties.

CHILE

Twenty-one collections were made in this country, including seed of specimens of **Persea americana**, **P. lingue** (a large native tree in Chile), and two other avocado relatives: **Beilschmedia Miersii** ("Bellote"), and **Cryptocarya** sp. ("Peumo"). Fine assistance in making these collections was obtained from Ings. Mario Vallejo, Gregorio Rosenberg, and S. Aaronsen, with the Ministerio de Agricultura; Mr. Carlos Bowers and Ing. Carlos Schwarzenberg of La Cruz.

Phytophthora root rot was identified by cultures made from avocado groves in the La Cruz and the San Vicente - San Fernando areas. Verticillium wilt was seen in the Quillota area, as was Dothiorella canker on Guatemalan type trees. Diseases of loquat and cherimoya were also investigated. Transportation in Chile was arranged through the courtesy of Mr. E. B. Hamill, in charge of the U.S.O.M. Agricultural Program in that country, and assistance and laboratory facilities by Dr. Carlos Munoz. There are some excellent avocado plantings in the La Cruz - Quillota area, and the people were very hospitable, cooperative, and interested in avocado problems. Particular appreciation is expressed to Mr. Bowers, Ing. Schwarzenberg, Ing. Luis Bastidas, Col. Benjamin Escobar, and the Asociacion de Productores de Paltas y Chirimoyas (ASPROPALCHI).

ARGENTINA

Argentina, along with Chile and Brazil, has appreciable acreages of commercial avocado production, primarily in the north and northwest sections of the country. Because of the lack of native species of **Persea** in Argentina the visit to the country was confined to the region near Buenos Aires. One collection of **Persea americana** was made, and **Phytophthora cinnamomi** was found causing peculiar cankers on plane trees (**Platanus** spp.), and **Casuarina** on an island in the delta of the Parana. At this Delta Plant Pathological Experimental Station **P. cinnamomi** also occurs on pine and peach trees.

BRAZIL

Brazil's commercial avocado production is principally in the southern area, but native species of **Persea** (primarily small tree types) occur over a wide area in this huge country. Four collections were made, comprising **Persea americana**, **P. poroza**, **P. alba**, and an unidentified species. A number of valuable contacts were made for

shipping future collections.

Phytophthora root rot was seen, and identified by root cultures, on trees near Campinas. Phytophthora canker was seen on avocado trunks in an experimental planting at the School of Agriculture at Piricicaba. Powdery mildew was found to be causing considerable damage on a number of trees of the West Indian varieties near Campinas. Considerable scab and Cercospora spot was also seen.

Many people were of great assistance in the work in Brazil, including Dr. A. A. Bitancourt, Head of the Division de Biologia Vegetal, Institute Biologica, Sao Paulo; Dr. Octavio Galli, Institute Agronomica, Campinas; Dr. Ralph Hanson, in charge of the Agricultural Program, E.T.A., Rio de Janeiro; and Dr. Araujo, Director Institute Agronomica, Belo Horizonte.

VENEZUELA

Four collections were made in Venezuela, of **Persea americana** and **P. caerulea**, an unusual blue-fruited species growing in the mountains near Caracas and near Maracay. **Phytophthora cinnamomi** was not found in cultures, though Phytophthora root rot is known to occur on cultivated trees in Venezuela. Transportation in Venezuela was provided by Dr. Warren Stoner; information on native species of **Persea** was obtained from Dr. Leandro Ariestequieta, Botanist at the Institute Botanico, Caracas.

TRINIDAD, PUERTO RICO, CUBA

Two collections of **Persea americana** were made in Trinidad, and **Phytophthora cinnamomi** was isolated for the first time in this country from avocado trees with root rot near Port of Spain. Dr. F. J. Simmonds was very helpful with the work in Trinidad.

One collection of **Ocotea leucoxylon** was made in the El Verde Forest in Puerto Rico, with the fine cooperation of Dr. William Pennock, and arrangements were made for further collections.

In Cuba, a **Persea americana** collection was made near Caimito, with the assistance of Dr. Frank Venning, Horticulturist with the U.S.O.M. in Havana. Phytophthora root rot was also seen in Cuba.

SUMMARY AND PRESENT STATUS OF COLLECTIONS

A total of 56 collections of avocado varieties, other species of **Persea** and related genera were made in these countries during the course of the trip. As a result of contacts made in several countries, ten additional collections were shipped to California during or shortly after this period also, making a total of 66 collections. Materials collected included 11 species of **Persea** (**P. americana, P. caerulea, P. chrysophylla, P. alba, P. durifolia, P. lingue, P. poroza, P. indica,** and three unidentified species); **Beilschmedia miersii, Cryptocarya** sp., **Ocotea leucoxylon, Ocotea minanum,** and several unidentified species of **Nectandra** and **Ocotea.** Many of these collections were from very wet locations, with clay soil and high rainfall; some in addition were made

where **Phytophthora cinnamomi** was present but trees were healthy.

In addition to these 66 collections a number of other materials have been received in recent months, and additional ones will be sent in the future.

Culture equipment was taken on this trip; a total of 46 cultures were made from avocado trees in 13 countries. **Phytophthora cinnamomi** was recovered from 15 of the 46 cultures. As the result of these cultures, supplemented by discussions with pathologists in various countries, Phytophthora root rot of avocado is now known to occur in Mexico, Honduras, Costa Rica, Peru, Chile, Argentina, Brazil, Venezuela, Trinidad, Puerto Rico, and Cuba. Cultures made on this trip established for the first time the presence of **Phytophthora cinnamomi** in Chile and Trinidad.

Several other avocado diseases, as well as diseases of other subtropical trees, were identified either by cultures or by examination of diseased trees. One new avocado disease was found, an unusual branch canker of Mexican avocado varieties in the experimental planting on Mt. Uyuca in Honduras, caused by a species of Phytophthora (probably **P. palmivora).**

Other diseases observed included Verticillium wilt in Ecuador and in Chile, caused by the fungus **Verticillium albo-atrum** (first reports in both of these countries); Dothiorella canker in Ecuador, and Chile caused by **Botryosphaeria ribis;** sun blotch virus in Peru (first time reported south of California); another branch canker in Peru caused by the fungus **Physalospora perseae**; a severe root and trunk rot in the Guillabamba Valley in Ecuador from which **Armillaria mellea** was isolated; a severe infestation of powdery mildew in Brazil, and several other foliage and fruit diseases.

Information on locations of materials collected was obtained from a number of sources. In each country pathologists, botanists, and horticulturists provided invaluable data on locations of native species and of avocado plantings. Drs. Caroline Allen and Lucille Kopp of the New York Botanical Garden were very helpful in furnishing information from their herbarium collections. References to research workers in most of the countries visited were kindly furnished by Professors K. F. Baker, H. D. Chapman, Lincoln Constance, T. H. Goodspeed, and E. F. Darley of the University of California; Professor E. C. Stakman, University of Minnesota; Professor J. C. Walker, University of Wisconsin; Dr. David Lloyd of the Commonwealth Institute of Biological Control, Fontana, California; and Dr. John Niederhauser of the Rockefeller Foundation, Mexico City.

Preliminary results of tests of these South and Central American collections indicate that several sources of high resistance have been found. **Persea caerulea**, **P. chrysophylla**, and **P. alba** are very resistant to root rot; no data are available yet on their compatibility with avocado. **P. caerulea** is the most vigorous and most nearly immune collection yet made; it is a small-fruited species, however, and compatibility experiments by Mr. E. F. Frolich at U.C.L.A. have shown that the small-fruited species are generally not compatible with avocado. Certainly this species is an excellent source of resistance for possible hybridization. Two other collections from this trip appear to have moderate resistance: **P. durifolia** from Peru, and a **P. americana** collection from Colombia. This latter is the first of the **P. americana** type to show any appreciable resistance in the foreign collections, and will be studied more intensively.