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AVOCADO ROOT ROT RESEARCH PROGRAM

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With the increased funds available through the Avocado Marketing Order, research on Phytophthora root rot of avocado has increased greatly during the past year. This article briefly summarizes some of this increased research, with emphasis on resistant rootstocks,

The following research scientists at the University of California, Riverside, are now involved in various phases of research on root rot: B. O. Bergh, T. A. DeWolfe, T.W. Embleton, N. T. Keen, J. V. Leary, D. E. Munnecke, T. Murashige, L. H. Stolzy, P. H. Tsao, A. I. Zaki, and G. A. Zentmyer; as well as K. F. Baker at the University of California, Berkeley, and E. F. Frolich at U.C.L.A. Also several graduate students and technicians are involved in the projects.

RESISTANCE

During 1972, collections have been made in Mexico and Central America by six collectors working in Mexico, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica and Panama. Some of these collections are covered in more detail in other articles in this Yearbook (By E. Johnson, and by Schieber and Zentmyer).

A total of 158 collections were made in the first nine months of 1972, including the following types of avocados and related species of this genus *Persea:*

Mexico — 29 collections

Avocado — many varieties
Persea schiedeana ("chinini")

Guatemala — 91 collections

Avocado — many varieties
Persea nubigena
Persea schiedeana
Persea steyermarkii?
Persea vesticula
Beilschmedia anay

El Salvador — 9 collections

Avocado — including Aguacate Mico
Persea schiedeana ("Chucte negro", "Chucte blanco")

Honduras — 1 collection

Avocado — "Aguacate de Anis"

Nicaragua — 13 collections

Avocado — including Aguacate Mico
Persea nubigena
Persea rigens
Persea sp. ?

Costa Rica — 12 collections

Avocado — several types
Persea pallida ?
Persea schiedeana
Beilschmedia ovalis
Ocotea sp.?

Panamá — 3 collections

Avocado
Persea sp.?

These collections include several different types of avocado and new species of the genus *Persea* that we have not been able to collect before. Some of the most interesting of these new collections are:

"**Aguacate de anis" —** a wild avocado type from the mountains of Honduras, collected for us by Professor Antonio Molina, botanist at the Escuela Agrícola Panamericana in Honduras. This is an unusual avocado with very strong anise odor in the leaves and twigs, but with a fruit with a thick skin like a Guatemalan type. Dr. Wilson Popenoe informed us some time ago about this interesting type.

***Persea rigens* —** this is a species of *Persea* closely related to the avocado; according to Drs. Allen and Kopp at the New York Botanical Garden it is more closely related to the avocado than most of the other species of *Persea,* and thus it might be graft compatible. We are now testing budwood for compatibility with avocado. This species, known as "Guaslipe" or "Guasquil", grows in Guatemala, Nicaragua and Costa Rica, and has fruit about the size and shape of a large date. Budwood was collected by the senior author in Nicaragua in January, 1972, and seeds and budwood from the same area by Dr. Schieber in September, 1972.

***Persea steyermarkii* —** this is a small-fruited species which is found in Guatemala and El Salvador; collections were made in Guatemala by Dr. Schieber. Trees reach considerable size. This species is probably not compatible with avocado, based on results with the original budwood collection.

***Persea nubigena (P. americana* v. *nubigena)* —** botanists disagree as to the classification of this tree, which has a fruit somewhat like a small Guatemalan avocado. It grows in the mountains in Mexico, Guatemala and Nicaragua, in Guatemala often at

altitudes of 7,000 to 9,000 ft. We collected seeds and budwood of this species in the mountains above Tecpan, Guatemala several years ago but survival of the material after shipment was poor. A number of additional collections have been made this year by Dr. Schieber in Mexico, Guatemala, and Nicaragua.

***Persea vesticula* —** this is another of the numerous species of the genus *Persea* that we had not collected until this year. The identification of this collection is not definite, but a collection made by Dr. Schieber in Guatemala is probably this species. This is another small-fruited type and we do not have information yet on compatibility or resistance.

***Persea schiedeana* —** this interesting relative of the avocado has fruit ranging from 3 to 6 inches in diameter or length; some fruit arc oval and others are elongate, depending on the area in which the species is found. It is known locally as "Chinini" in Mexico, "Yas" in Costa Rica, and "Chucte", "Chupte" or "Coyo" in other areas. *P. schiedeana* grows as a native tree in Mexico, Guatemala, El Salvador, Honduras, and Costa Rica. The senior author collected it in several areas (Mexico, Honduras and Costa Rica); these early collections showed variable resistance. Dr. Schieber and E. Johnson have collected this species recently in Guatemala and El Salvador.

In addition to these species of *Persea,* a number of different avocado seedlings have been collected from various remote areas in Mexico, Guatemala, El Salvador, Nicaragua, and Costa Rica. Some of these trees were only found after several hours of hiking into some of the mountainous areas.

***Beilschmedia anay* —** a relative of the avocado, this tree is classified in the genus *Beilschmedia.* It is a large tree with fruit similar to a medium-sized Fuerte avocado, but purplish-black. The tree grows in Mexico and in Guatemala and was observed by Dr. Wilson Popenoe in Guatemala many years ago. Dr. J. Vasquez in Mexico and Dr. Schieber in Guatemala have collected material for us.

In California also the search for root rot resistance has been increased, with emphasis on trees in old root rot areas that have survived the disease and are still healthy. One difficult problem here is in attempting to recover the rootstock of these trees, as in California essentially all trees are grafted, in contrast to the many seedling trees that are found in Latin America. Thus it is necessary to try to induce sprouts from the rootstock of the California trees, either by cutting off the scion or by girdling the tree just below the graft union. We have found several trees that show possibilities of resistance in California avocado groves; the rootstocks have been recovered from two of these recently and these rootstocks are now being propagated by means of rooted cuttings, by E. F. Frolich at U.C.L.A.

Previous collections and test materials in the resistance program are being tested continually in the greenhouses at Riverside and in field plots in southern California. In field plots established in the past two years some of these rootstocks are showing appreciable resistance.

In these field plots in southern California avocado areas, our trees on Duke 6 cuttings, Duke 7 cuttings, and G22 (Guatemalan) cuttings are showing encouraging results in resistance tests after two to three years in the field. In some cases up to 80 per cent of the trees on Topa Topa seedling rootstocks are showing root rot symptoms, compared

to very low percentages of trees with root rot on the Duke and Guatemalan cuttings.

The trees for these field plots were produced by E. F. Frolich in our cooperative program at U.C.L.A., where cuttings are being rooted for these field trials. In the field plots also we have had excellent cooperation from the Farm Advisors in the avocado-producing counties in southern California — Len Francis in Los Angeles and Orange counties, George Goodall in Santa Barbara County, Don Gustafson in San Diego County, Marvin Miller in Riverside County, and Bud Lee in Ventura County.

Thus, the accelerated root rot program is giving us many more types of rootstocks to test for resistance, and more trees propagated on promising rootstocks for large-scale testing in the field in California. In field plots established in the last two years, over 1950 trees have been planted.

Also, in cooperation with Dr. N. T. Keen and Dr. A. Zaki in the Department of Plant Pathology, we are developing information on the nature of anti-fungal chemicals that are present in leaves, twigs, and roots of *Persea borbonia* and *P. caerulea,* species of *Persea* that are resistant to root rot.

OTHER PHASES OF ROOT ROT RESEARCH

In addition to the research on resistance, studies have been expanded in other phases of control of the disease, as well as studies of the fungus *Phytophthora cinnamomi,* and research has also been accelerated on the effects of irrigation on the disease and on compatibility.

The studies on other phases of control include investigations of soil fungicides, fumigants, systemic fungicides, amendments, biological control, and microbial antagonism. Involved in these phases are the following research scientists: Dr. T. W. Embleton (Department of Plant Science, Riverside), Dr. K. F. Baker (Department of Plant Pathology, Berkeley), and Drs. D. E. Munnecke, P. H. Tsao, and G. A. Zentmyer (Department of Plant Pathology, Riverside).

A number of new organic chemicals have been tested in our laboratory at Riverside in further attempts to find a satisfactory and inexpensive material that could be applied to trees in early stages of disease and that would prevent disease development. Several of these new chemicals, supplied by some of the large chemical companies, show promise in these laboratory and greenhouse tests and are being tested further. One new systemic chemical has some effect on Phytophthora but is somewhat toxic to avocado trees.

Dr. D. E. Munnecke is studying soil fumigants such as methyl bromide in the laboratory with the objective of developing detailed information on how this fumigant affects the avocado root rot fungus (mycelium and spore stages), and how effective it is in penetrating roots and killing the fungus. This information will be useful in fumigation of small areas of infection and also for use in barrier treatments.

Dr. P. H. Tsao is studying *P. cinnamomi* from the standpoint of its survival and activity in soil, and is developing methods for producing chlamydospores in large numbers in the laboratory, and for direct isolation of the fungus from the soil so that it will be possible to

obtain more accurate figures of population of *P. cinnamomi* in the soil. He is also developing some significant information on the activity of sporangia and zoospores in soil.

Dr. K. F. Baker has been studying *P cinnamomi* while on sabbatical leave in Australia and is beginning to develop some very significant information on suppressive soils. Apparently there are certain soils in Australia where the development of the root rot fungus is suppressed, probably by the action of other soil microorganisms, according to Dr. Baker, this situation is being studied further, to develop more information on it in relation to transferring the protective effect to other soils and to defining the mechanism involved.

The genetics of *Phytophthora cinnamomi* is being studied by Dr. J. V. Leary in the Department of Plant Pathology, Riverside; some of this, in relation to variation in the fungus, is in cooperation with G. A. Zentmyer. Dr. Leary is studying the basic genetics of the fungus also, with the aim of better understanding the development of the fungus and of developing information that would ultimately be useful in controlling the disease. From these studies it appears that the oospores of *Phytophthora* do not contain ribosomes, but do contain ribosomal RNA and ribosomal protein; this lack of intact ribosomes may be related to the difficulty in germinating these spores. Also the sensitivity of isolates of *P. cinnamomi* to antibiotics such as streptomycin and vancomycin is being studied. We are also continuing other studies of the fungus, such as the research on chemotaxis and electrotaxis of zoospores, the effect of various nutrient levels on the fungus and the stimulation of oospore production by the soil fungus, *Trichoderma.*

Effects of varying oxygen levels and water in the soil are being investigated by Dr, L. H. Stolzy, and T. Szuszkiewicz Department of Soils and Agricultural Engineering, Riverside. He is also developing some information on relative porosity of avocado roots, in comparison with resistant species of *Persea.*

Dr. T. Murashige, Dr. B. O. Bergh, and R. Makino in the Department of Plant Science, have obtained some encouraging initial results with test tube pollinations between the avocado and some of the Phytophtora-resistant *Persea* species. Irradiation of avocado seeds is being tried, with the objects of developing mutant types that might be more resistant to root rot, or be more compatible with the species of *Persea* that are resistant to root rot. Budsticks will also be irradiated with the same objectives in mind. Research is also being conducted on the nature of the graft incompatibility between the avocado and the Phytophthora-resistant species of *Persea.*

In conclusion, this greatly increased emphasis on research on many aspects of the serious avocado root rot disease should certainly help in providing the answers that are necessary in order to be able to control this problem satisfactorily.