California Avocado Society 1952 Yearbook 37: 103-106

RESEARCH ON AVOCADO ROOT ROT

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

Much of this work involves cooperative investigations with Drs. D. G. Aldrich, F. F. Halma, D. L. Lindgren, S. J. Richards, C. A. Schroeder, and with J. J. Coony, G. E. Goodall, C. D. Gustafson, P. W. Moore, K. M. Smoyer of the Agricultural Extension Service.

This article provides a brief summary of the various types of experiments that have been conducted and are being conducted at the present time in efforts to control the avocado root rot disease. A number of different approaches to the problem are under investigation. These may be grouped into the following divisions:

1) Resistant rootstocks

2) Other crops for replanting disease areas

3) Survey of other plants affected by this disease

4) Soil amendments

5) Fungicides and fumigants

6) Irrigation

7) Survey of native soils

8) Soil type

9) Biology of the causal fungus

10) Resistant rootstocks.—Research of this important phase is in a relatively early stage. Several related species of *Persea* from Mexico and Central America, brought into California in recent years by Dr. C. A. Schroeder and interested avocado growers, have been tested at Riverside and found generally susceptible to the disease. *Persea longipes, P. Hague, P. indica, P. floccosa,* and *P. nubigena* have been found to be susceptible. A number of collections were made in Central America in the summer of 1952; the aim of this trip was to collect wild avocados or other *Persea* species primarily from wet locations. The California Avocado Society aided in financing the trip. These collections are now being established; tests for root rot resistance are underway with some of them. Tests involving large numbers of seedlings from 40 different named avocado varieties in California are also being conducted in the hope that some resistance to the disease will be found here.

Cooperative fumigation tests with Dr. D. L. Lindgren have provided data on tolerance of avocado seed to ethylene dibromide and methyl bromide. Investigations are currently

being undertaken on the tolerance of avocado bud-wood and budwood of other species of *Persea* to these fumigants and to an oil dip.

2) Other crops for replanting disease areas.—Inoculations and limited field tests have indicated that the macadamia nut *(Macadanna terniifolia),* cherimoya *(Annona cherimola),* two types of persimmon *(Diospyros kaki* and *D. lotus),* and sweet and sour orange *(Citrus sinensis* and *C. auranlium)* are resistant to the disease. Thus these types of crops are possibilities for replanting areas where avocado trees have been removed or have become unproductive because of root rot. The Agricultural Extension Service should be contacted for advice on use of such crops in the various counties.

3) Other plants affected.—The avocado root rot fungus *(Phytophthora cinnamomi)* has a wide host range. Other plants on which this fungus causes either a root rot or canker include: camellia*, chestnut, heather*, incense cedar*, pine*, pineapple, Italian cypress*, juniper*, peach, walnut, rhododendron, cinchona, cinnamon, Lawson cypress*, myrtle*, and arborvitae*. The fungus has been found in California on the plants starred (*).

4) Soil amendments.—Included under this heading are trials on the effect on disease development of varying amounts of nitrogen, potassium, and phosphate, of different types of organic matter, gypsum, lime, and sulfur. Greenhouse and field trials in which varying amounts of N, P, and K have been added to infested soil have revealed no differences in disease development. More detailed studies are underway along this line with Dr. Frank Bingham, who is initiating solution culture studies with the avocado.

Alfalfa meal additions have resulted in improvement of the condition of diseased trees in some of the field plots established, not in others. Adding this material, at the rate of 5 to 15 tons per acre, to diseased soil in containers has invariably resulted in greatly improved growth of seedlings planted in the treated soil. Field and greenhouse applications of gypsum and of sulfur have given no benefit. Greenhouse applications of lime have given indications of less disease development at the higher pH levels (pH 8), though even at pH 8 the roots of seedlings in diseased soil weighed about one-fifth as much as those in healthy soil at pH 8. This is being investigated further in the field. Krilium is also under investigation in relation to root rot.

5) Fungicides and fumigants.—Several fumigants, [^] including chloropicrin, ethylene dibromide, and a mixture of chlorinated hydrocarbons (D-D, Dowfume N) will kill *Phytophthora cinnamomi* if sufficiently high dosages are used. Cooperative investigations with C. D. Gustafson have also shown that methyl bromide is an effective fumigant against *P. cinnamomi.* The fungus can thus be eliminated from containers of soil, piles of nursery soil, or m the case of an isolated spot of infection in a grove. Large numbers of field plots, where avocado trees were removed, the soil fumigated and re planted to avocados, showed that where infection is widespread it is impractical to fumigate. The fungus was eliminated from fumigated areas for two to three years, but subsequent re-invasion of the fungus resulted in severe infection after this time. The fumigants are effective against *P. cinnamomi* in soil at the following dosages: chloropicrin 30 gal./acre, methyl bromide 400 lbs./acre, D-D and Dowfume N at from 100 to 125 gal./acre.

[△]Materials have been supplied by Dow Chemical Company, Neil A. MacLean Company, and Shell Chemical Corporation.

A screening program for detecting fungicides that are effective against the root rot fungus has been established in the laboratory. Several materials have appeared that will kill the fungus at dosages below that at which they will injure avocado roots. Such materials are being tested by applying to avocado seedlings in the glasshouse and to diseased trees in the field. The fungicide nabam (Dithane D-14, Parzate liquid) has shown some promise when applied to trees in the irrigation water; this is being investigated further, as are other materials.

6) Irrigation.—The close connection between avocado root rot and excess moisture has been recognized for some time. Cooperative experiments with Dr. Sterling Richards have emphasized the fact that *Phytophthora cinnamomi* is the primary causal agent in the disease, and have also indicated the importance of soil moisture in the problem. The disease progresses more rapidly and is more severe in its manifestations in the presence of excess soil moisture than when moisture conditions are more optimum. This points to the role of careful irrigation in retarding disease damage, particularly of course on the poorly drained soils where the disease is most common. This relation also indicates the advisability of any measure that will prevent accumulations of water during winter rains, such as adequate surface drainage.

As a corollary to the fact that the fungus is favored by excess soil moisture, it is sensitive to low moisture, being killed out when moisture content of sandy loam drops to around one percent. This indicates that disease progress may be retarded by maintaining a dry zone at the margin of an area infested with *P. cinnamomi.*

7) Survey of native soils.—Numerous soil and root samples have been taken from areas in San Diego County that have never been planted to any crop, in an effort to find whether P. *cinnamomi* is a native inhabitant of southern California soils. To date the fungus has not appeared in these cultures, nor in cultures from healthy avocado groves. Similar samples have been taken in Mexico and in Central America; these have shown that the fungus is present but not common in these countries. The fungus has been found in avocado and other types of nursery stock in southern California nurseries, indicating that this is one means by which it may be transported.

8) Soil type.—Early observations on the disease pointed out that it is primarily of importance on poorly drained soils. These may be of two types—heavy soils, and soils with a permeable surface soil but an impervious horizon at varying depths below the surface. This relation still holds true, and provides an obvious remedy for the disease in future plantings. This is to plant only on well drained soils. This fact does not provide any relief for plantings already established on inadequately drained soils, nor for plantings which are sure to be established in the future on marginal soils.

9) Biology of the fungus.—Various types of laboratory investigations have been conducted with *P. cinnamomi.* These have provided basic data on the types of spores produced by the fungus and the nutritional, microbiological, and temperature conditions under which they are produced; on the effect of temperature and pH on the growth of the fungus, on rapid means of isolating and identifying the fungus, and on cross-infection tests with the fungus from other hosts. In brief, *P. cinnamomi* produces two

spore stages: sporangia in which swimming spores (zoospores) are produced; and resistant spores, or oospores. The optimum temperature for sporangial production is 77° F., for oospore production, 72° F. The fungus itself makes its best growth at from 77 to 82° F. and, in general, grows better at acid pH levels, though the nitrogen source has an effect on growth in relation to pH. Several tests have shown that there is no difference in the strains of *P. cinnamomi* from different hosts ; the strain from camellia will affect avocado, and vice versa, for example.