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SANTA BARBARA COUNTY AVOCADO ROOT ROT SOIL SURVEY

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The seriousness of Phytophthora root rot in avocado orchards in Santa Barbara County is closely related to the soil profile characteristics indicated by soil series. The soils with the least root rot hazard are those of the recent alluvial group; while the greatest hazard occurs on the terrace soils with claypans. Among these hazardous soils, the slope of the soil surface appears to also affect the disease occurrence: the steeper the slope, the lower the incidence. Surface soil texture has less effect on disease prevalence than subsoil drainage characteristics.

These findings are based on a survey covering a total of 2045 acres, of which 328 acres were known to be infested with Phytophthora cinnamomi. This fungus is the basic cause of the root rot disease, but the soil conditions determine its severity and rate of spread.

In 1955, a preliminary avocado root rot soil survey in Santa Barbara County showed a close correlation between certain soil series and their susceptibility to fungus development (6). It was suggested that because of the wide variety of soils in the area and the widespread distribution of the fungus, it was important to evaluate this factor. Subsequent surveys in the avocado districts, such as Fallbrook (3), and Escondido (1), have shown that trees growing in many types of soil have been affected, but the amount or extent of damage is much greater on some soils than on others.

This present survey is not only part of a statewide program to evaluate avocado soils for root rot hazard (1, 2, 3, 8), but will be helpful to local growers in assessing their root rot hazard.

The survey started with the purchase of a set of recent aerial photos. Each avocado orchard was outlined on the photos—Figure 1. Diseased areas were plotted, based on hundreds of P. cinnamomi fungus cultures made during the past ten years. The present extent of the infections were mapped on the basis of visual conditions of the trees.

The soils information was then mapped on overlays from a similar scale soil map by inspection (4); this illustrated in Figure 2. The acreages were planimetered and accumulated. For the purpose of this study we have assumed that all properties have had an equal chance of infection.

The 1961 Agricultural Commissioner Crop Report shows 1683 acres of avocados (5). This survey totaling 2045 acres, included a number of orchards that have died of root rot in recent years and have been replanted with other crops, mainly lemons. Also, many avocados are interplanted in old lemon orchards. These are the reasons for the larger acreage in this survey than that in the Crop Report.

FIGURE 1. Aerial photo showing outlines of avocado groves. Solid black lines outline healthy groves and dotted white line shows area infected with P. cinnamomi. Surrounding orchards are lemons.

RESULTS OF SURVEY BY PROFILE GROUPS

Previous estimates of root rot incidence in Santa Barbara County have ranged from 10% to as high as half of the acreage immediately threatened (6). The rate of disease spread and the decline of the avocado trees was known to vary greatly depending on soil condition.

The results of this survey show an average root rot incidence of 16% as shown in Table 1. The rate varied from 4% to 22%, depending on the soil profile grouping. They are located on an old terrace, claypan soil—Milpitas fine sandy loam.

Table 1—Avocado Root Rot Diseased Acreage and Total Acreage in Santa Barbara County by Soil Profile Groups

Profile Groups	Total Acres	Diseased Acres	Diseased %
I—Recent Alluvials	419	16	4
II & III—Old Alluvials	193	40	21
IV—Lower Terraces	699	155	22
VI—Higher Terraces	210	46	22
VIII & IX Upland Primaries	524	72	14
Total	2045	328	16%

The hazard of root rot appears to be much less on the Group I soils— recent alluvials—that have no subsurface drainage impairment. Groups VIII and IX—primaries—were combined since they are equally intermediate in hazard and are located in more isolated upland positions. Groups II and III—old alluvials—were summarized together since they appear similar in the field and are equally hazardous. These soils contain sufficient internal drainage impairment for rapid disease development. The old terrace soils, Groups IV and VI, have equal hazard and are separated only because of position and slope differences. Their hazard is the greatest due to the pronounced claypan nature of the soil profile.

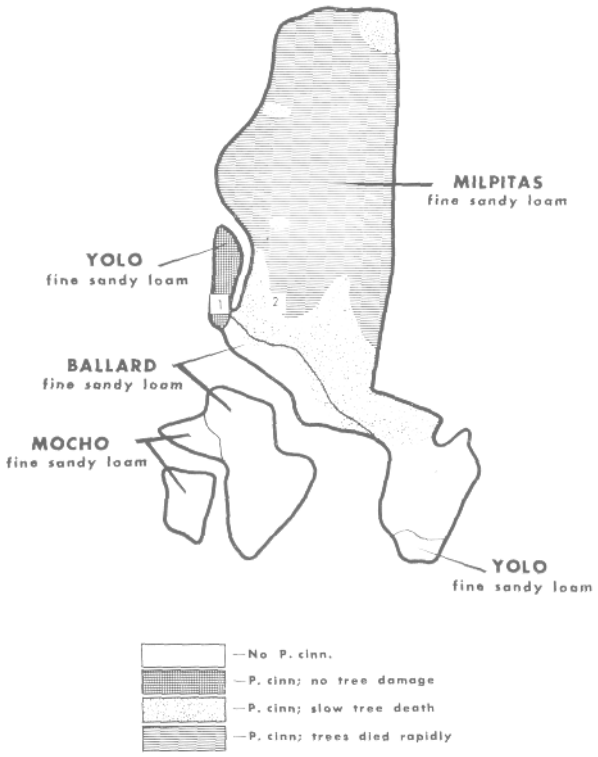

FIGURE 2. Soil information entered on overlay of Figure 1, showing soil types and P. cinnamomi diseased area. Tree condition in diseased area varied greatly depending on soil. Figure 3 is a photo taken at (1) above, showing the excellent tree growth on a claypan soil. Note that all soil types have the same surface texture — fine sandy loam — but tree condition varies mainly with series.

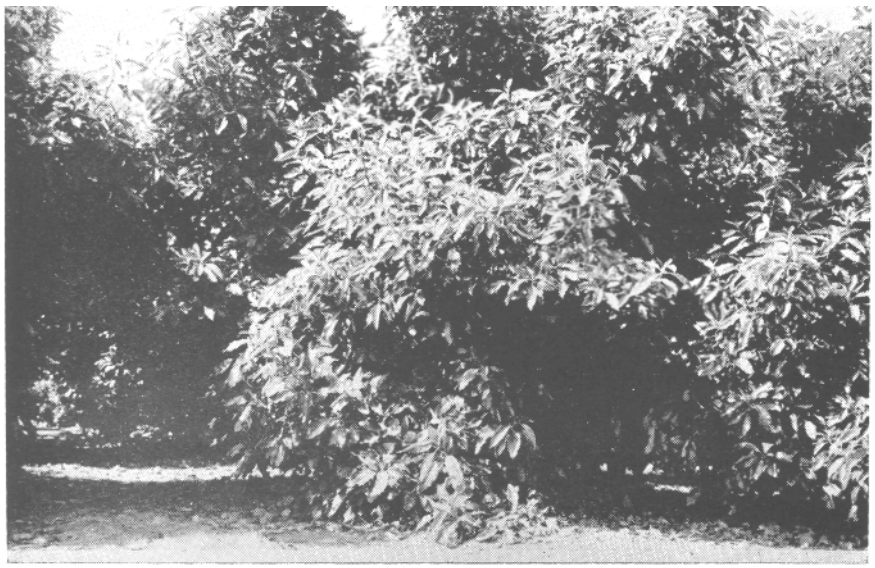

FIGURE 3. Excellent tree condition, in spite of P. cinnamomi presence, on recent alluvial soil — Yolo fine sandy loam. Photo taken at point (1) in Figure 2.

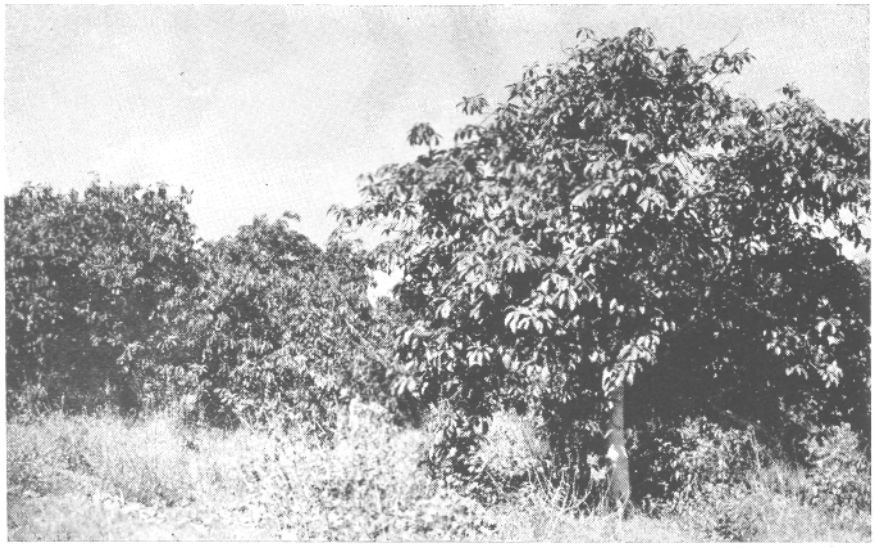

FIGURE 4. Typical avocado root rot disease symptoms on terrace claypan soil—Milpitas fine sandy loam. Photo taken at point (2) in Figure 2. Note vacant land where dead trees have been removed.

Figures 3 and 4 illustrate the difference in tree growth in a diseased area when there is a soil difference. The trees pictured in Figure 3 have been infected with **P. Cinnamomi** for sixteen years and have always appeared healthy. They are on a deep recent alluvial soil—Yolo fine sandy loam. The trees pictured in Figure 4 are just a few remaining trees in another part of the same orchard and are no longer producing satisfactory.

ROOT ROT OCCURRENCE BY SOIL SERIES

The great variation in root rot incidence, related to soil series, is well illustrated in Table 2. The results of this survey are presented for each of the thirteen principal series, shown in increasing order of disease.

Soils of the Sorrento, Yolo and Mocho series are alluvium from the Maymen, Sespe and Gaviota soils. They occur on gently sloping, recent alluvial fans and narrow flood plains.

Sorrento, the predominant series, has a dark grayish-brown surface and a texture varying from loamy sands to clay loam. The subsoil texture is similar. Roots and water penetrate easily.

The main difference between Sorrento, Yolo and Mocho is the amount of lime in the subsoil and substrata. Yolo subsoil has a neutral reaction. Sorrento is moderately basic, while Mocho is calcareous.

Ballard and Carpinteria soil series have developed from older alluvial deposits. Their chief difference from the more recent alluvials is moderate to distinct profile layers. The subsoil has a slightly finer texture and is slightly to moderately compact. Only a few of the finer roots extend into this layer and water penetration is impaired.

The Aliso, Milpitas and Olivenhain series have well-defined claypan subsoil layers and occupy old terraces along the coast. Surface texture is usually a fine sandy loam or

loam. Some areas have considerable gravel or large cobblestones and boulders.

Table 2—Incidence of Avocado Root Rot Disease in Santa Barbara County by Soil Series

Soil Series	Total Acres	Diseased Acres	Diseased %
Mocho	68	0	0
Nacimiento	119	2	2
Sorrento	256	10	4
Baywood	34	1	4
Aliso	122	5	4
Yolo	88	7	8
San Andreas - Tierra	130	14	11
Sespe	238	30	13
Ballard	111	24	22
Milpitas	544	149	27
Zaca	130	38	29
Carpinteria	39	14	36
Olivenhain	80	32	40

Few roots penetrate into the claypan subsoils. Internal soil drainage is restricted to the area above the pan. The lower subsoil of the Aliso and Milpitas series is somewhat less compact while the clay subsoil of the Olivenhain series rests on semiconsolidated stratified old terrace material. These soils are subject to considerable sheet erosion. The Milpitas series also has many deep, vertically-sided gullies; profile characteristics are not so well developed in this escarpment phase.

Soils of the Nacimiento and Zaca series have formed over soft calcareous shale of marine origin. The Sespe series rests on shale bedrock of non-marine formation. Textures of these series are clays or clay loams. All three series are calcareous. Chlorosis is particularly a problem with the Zaca and Sespe soils. Despite the fine texture, these soils are usually porous and easily crumbled, especially the Zaca and Nacimiento.

Subsoils of the Sespe are rather blocky in structure and are penetrated only by the coarser roots. Parent material of the Zaca series is a soft, weathered shale with little soil intermixed with it. Considerable soil is intermixed with the Nacimiento parent material. The Sespe parent material is a hard shale or clayey sandstone, somewhat shattered and mixed with considerable soil.

One of the surprising results is the low disease occurrence on the Nacimiento series; only 2% infested trees. This is probably due to a lack of infection opportunities due to its upland location. Another surprising series was Aliso with just 4% damaged trees. On checking back, it was found that most of the orchards on Aliso were located in an area of relatively little disease occurrence.

The high disease incidence on the Carpinteria series (36%) was somewhat surprising. It was concluded that, if a Sorrento or similar recent alluvial that is stratified can bring on a rapid tree deterioration as described by Goodall, et al., earlier (7), then the amount of profile development plus the clay content of the Carpinteria series puts it well into the severe hazard group. Figure 5.

SURFACE SOIL TEXTURE EFFECT

The texture of the surface soil was studied in relation to root rot incidence and the results are shown in Table 3. The trend is for the disease to be worse on the finer-textured soils. Clay soils in themselves can hasten tree deterioration. But profile and other subsurface soil characters are more importantly related to root rot than texture by itself. Where both profile development and clay texture occur, the maximum incidence of the disease was found, i.e., Carpinteria and Olivenhain soils.

STEEPER SLOPES SHOW LESS ROOT ROT

The soils studied had surface slopes that ranged from nearly flat to very steep; the data is summarized in Table 4. The soils in profile Groups I, II, and III—alluvials—were not included since they fell mainly in the 0-8% class only.

For terrace and upland soils—Groups IV, VI, VIII, and IX—where water can accumulate above a claypan or other profile restriction, then slopes can well be considered a factor in root rot development. In this case, the nearly level terrace soils have many depressions in the pan where water can collect. While the steep terrace soils, called terrace breaks, have little or no pan under Santa Barbara County conditions and therefore do not collect much excess water. Infections spread rapidly downhill on steep slopes but the rate of tree decline was slower. Where clay soils occur, less difference was noted in the slopes.

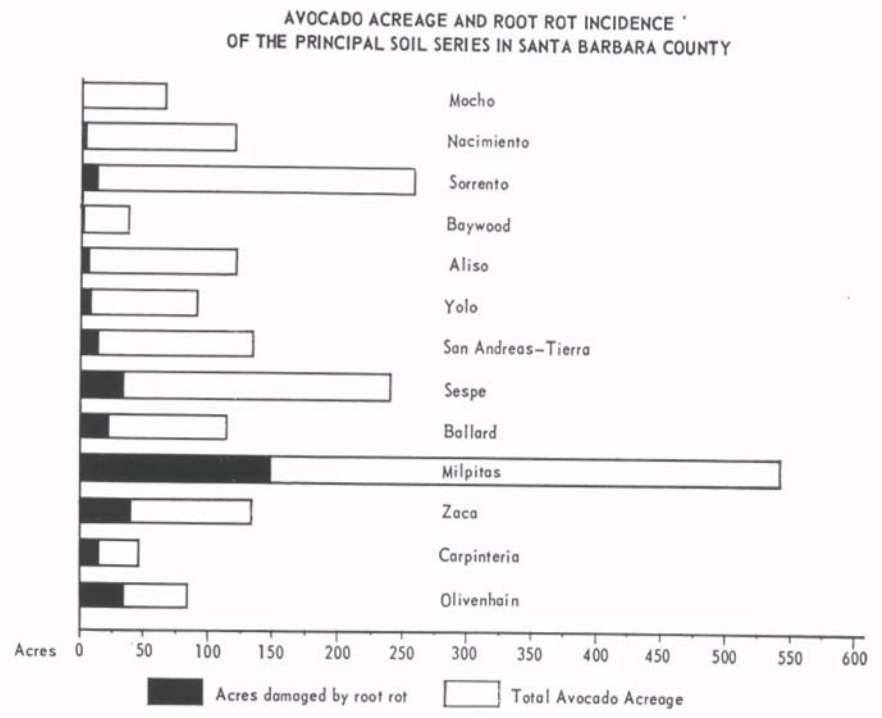

Table 3—Effect of Surface Soil Texture on Incidence of Avocado Root Rot in Santa Barbara County

Texture Class*	Total Acres	Diseased Acres	Diseased %
loamy sand	17	1	3
loamy fine sand	31	1	3
sandy loam	139	10	7
fine sandy loam	870	172	20
loam	295	58	20
clay loam	187	16	9
clay	355	60	17

*stony or gravelly phases were grouped with their main texture group.

Table 4—Effect of Soil Slope on Incidence of Avocado Root Rot in Santa Barbara County*

Slope Class*	Acres Total	Acres Diseased	% Diseased
0 — 8%	163	66	41
9 — 30%	741	156	21
31 + %	528	48	9

*Soils of the recent alluvial and old alluvial profile groups are not included since most were in the nearly level class.

Root Rot Hazard Related to Soil Series

Based on this study, the following rating of soil series is made to evaluate the root rot hazard in Santa Barbara County.

Slight Hazard	Moderate Hazard	Severe Hazard
Baywood	Aliso	Ballard
Elder	Nacimiento	Carpinteria
Mocho	San Andreas - Tierra	Milpitas
Sorrento		Montezuma
Yolo		Olivenhain
		Santa Lucia
		Sespe
		Watsonville
		Zaca

Considerable variation occurs from spot to spot, so each property should be studied individually. Noting the profile characteristics as they vary from the typical, usually accounts for some of the variables. Another is management practices. An excellent soil can be mismanaged and root rot damage aggravated by some of the following: 1) excess soil moisture, 2) movement of the fungus by soil or water; 3) not evaluating the problem at an early stage Preventing infection is still one of the prime concerns of growers whose groves are not presently infested. Further details are presented on this in another publication (9). Your local Farm Advisor and Soil Conservationist are available to help determine which soils are best suite avocados.

This survey of avocado orchards in Santa Barbara County has shown that an average of 16% of the acreage is affected with Phytophthora root rot at present. The incidence and severity of the disease varies mainly with the soil type. The principal soil series have been rated as to root rot hazard. In general the recent alluvial soils are the safest and the old terrace soils are the most hazardous. Continued planting of these

hazardous soils with the large number of potential infection sources, should be questioned. Until better fungus control measures or more resistant rootstocks are found, plantings on the slight hazard soils are the safest.

LITERATURE CITED

1 Burns R. M., G. Borst, C. D. Gustafson, G. A. Zentmyer, and W. A. Thorn — "Escondido Area Avocado Root Rot Soil Survey, California Avocado Society Yearbook 1961, pgs 99-103.

2 Burns, R. M., K. D. Gowans, R. B. Harding, and G. A. Zentmyer —"Avocado Root Rot Soil Survey," California Agriculture, May 1962, pgs 6-7.

3 Bums R. M. J. H. Miner, C. D. Gustafson, G. A. Zentmyer, and W. A. Thorn — "Correlation of Soil Series and Avocado Root Rot Damage in the Fallbrook Area," California Avocado Society Yearbook 1960, pgs110-113.

4 Cole R C, R. A. Gardner, K. D. Gowans, L. L. Begg, G. L. Huntington and L C Leifer — "Soil Survey of the Santa Barbara Area, California," U.S.D.A. Soil Survey Series 1944, No. 8, March 1958, 178 pages.

5. Cummings, W. S. — "Agricultural Crop Report 1961," Department of Agriculture, Santa Barbara County, 7 pages.

6. Goodall, G. E. — "Avocado Root Rot Disease in Santa Barbara County," California Avocado Society Yearbook 1955, pgs 149-153.

7. Goodall, G. E., A. W. Marsh, G. A. Zentmyer, and S. J. Richards —"Soil Stratification and Phytophthora Root Rot Occurrence in Avocado Orchards," California Avocado Society Yearbook 1960, pgs 125-129.

8. LaRue, J. H., and R. M. Burns — "Tulare County Avocado Soil Survey," California Citrograph, January 1961, pgs 84-87.

9. Zentmyer, G. A., A. O. Paulus, and R. M. Burns — "Avocado Root Rot," University of California Circular 511, March 1962, 18 pages.