economically impractical. Soil applications of 3,200 pounds of ferrous sulfate or ferric sulfate per acre were required to correct iron chlorosis in grain sorghum. In the case of iron oxide, as much as four times this amount was still ineffective. Soil applications of Sequestrene 138 Fe Iron Chelate was only slightly effective at rates up to 128 pounds per acre. In preliminary field trials with ferrous sulfate, ferric sulfate and Sequestrene 138 Fe, soil applications appeared to be even less effective than in the greenhouse.

Calcareous soils

In all cases of iron chlorosis encountered, the soils have been found to be calcareous. However, there are many other soils which are equally calcareous where no chlorosis is found. The reason for this is not yet understood. It has also been observed that second growth or regrowth of sorghum is much more chlorotic than the first growth. Studies are being continued toward understanding these and other related problems. However, from the grower's standpoint, iron deficiency in sorghum and related crops can be identified by the typical interveinal chlorosis or striping the full length of the leaf (as illustrated). This usually occurs first on the upper leaves. In cases of severe iron deficiency the plant may be stunted, white in color and may eventually die.

With only one season's experience in the correction of iron deficiency by foliage sprays, there are many details yet to be worked out. These include timing of applications, the need and timing of mutliple applications in severe deficiencies and the possibilities for low gallonage-high concentration sprays, airplane application, and correction of iron deficiencies in other plants.

Summary

Preliminary studies during the past season indicate the following procedures where iron deficiencies exist:

(1) In cases of mild iron chlorosis, apply one foliage spray about 25 days after planting. In areas where severe chlorosis and stunting occur, two or possibly three sprays may be required. The first spray should be applied about 10 days after emergence and the second about 25 days after emergence. The need for a third spray can be detected by observation of the possible recurrence of the chlorosis.

(2) The concentrations to be used should be approximately 3 per cent ferrous sulfate solution (25 pounds per hundred gallons of water). A wetting agent such as X-77 is essential. The spray should be applied at about 35 pounds pressure to form a mist for good coverage of the foliage. The gallonage necessary for good coverage will depend upon the size of the plant. However, 20 to 50 gallons of directed spray should be sufficient.

(3) Soil applications are not recommended because of the high rates required to correct the deficiency.

B. A. Krantz is Extension Soils Specialist, University of California, Davis; A. L. Brown is Lecturer, Department of Soils and Plant Nutrition, U. C., Davis; B. B. Fischer is Farm Advisor, Fresno County; W. E. Pendery is Farm Advisor, Tulare County; and V. W. Brown is Farm Advisor, San Diego County.

AVOCADO ROOT ROT SOIL SURVEY

R. M. BURNS • K. D. GOWANS R. B. HARDING • G. A. ZENTMYER

Avocado root rot, caused by the fungus Phytophthora cinnamomi, is the most important disease affecting avocados throughout the world. In California approximately 4,000 acres of avocados have been damaged. Trees growing in many types of soils have been affected, but the amount or extent of damage is much greater on some soils than on others. Previous investigators have pointed out that when the fungus is present, avocado trees growing in soils with poor internal drainage are most susceptible to root rot damage. Recent surveys have shown that the rate of spread is usually slow on deep, medium-textured (loam, fine sandy loam) soils and will range from moderate to rapid on many other soils.

THE PRESENT survey is a part of the state-wide investigation of the avocado root rot problem in California. To date this survey includes over 100 soil classifications on 50 groves in Fresno, Los Angeles, Orange, Riverside, San Diego, Santa Barbara, San Bernardino, Tulare, and Ventura counties. All of the major avocado-producing areas in the state are represented in this study. Extensive soil surveys have previously been reported for the avocado districts of Santa Barbara, Fallbrook and Escondido—as well as the potential avocado production areas of Tulare County.

Avocado root rot does not develop or spread at the same rate through all groves. In some groves several acres of trees will die in a year or two, while in other groves only a few trees die over a period of five years or more. Root rot damage was evaluated according to the rate of the root rot spread. Each grove was then placed into one of three rating classes: Class I, very slow spread, only one or two trees affected a year; Class II, moderate spread, several trees to nearly an acre a year affected; and Class III,

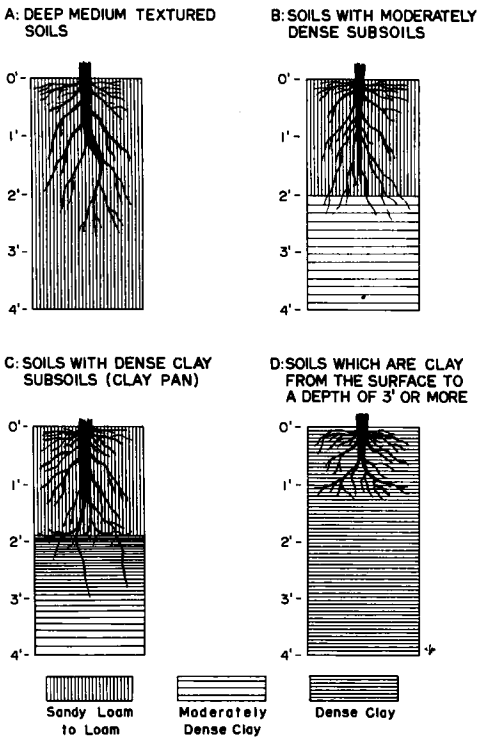
Mature avocado tree dying from root rot in the Fallbrook area of San Diego County. The soil series in this area is Merriam with a clay layer at 2 to 3 feet.

rapid spread, groves in which root rot fungus affected over an acre or more in a year.

The soils were classified according to soil series in each grove investigated. A soil series is a group of soils with similar characteristics and is given a geographical name identified with the area in which the soil series was first found. Some of the characteristics which distinguish soil series are color, pH, arrangement and thickness of the soil layers, and the kind of material from which the soil developed. Seventeen soil series have been identified thus far in the survey. They range from young, deep, permeable soils on recent alluvium to old soils with clay pans.

The soil series were placed into four principal groups having similar profile characteristics: Group A, deep, medium textured soils (Botella, Mocho, Hanford, Sorrento, Yolo, and Vista); Group B, soils with moderately dense subsoils (Ramona and Fallbrook); Group C, soils with dense clay subsoils or clay pans (Bonsall, Las Posas, Placentia, Rincon, Carlsbad, Twin Oaks, and Merriam); Group D, soils which are clay from the surface to a depth of three or more feet (Diablo and Montezuma). A schematic interpretation of these four soil groups is illustrated.

Schematic drawing of the four principal soil survey profile groups.



The soil series is listed in the table with the corresponding rate of spread of fungus in the groves. The Bonsall soils, for example, were found on three properties and in two of the groves, the rate of spread of avocado root rot was rapid while in the other grove the rate of spread was moderately rapid. Other soil series in which the root rot was found to spread rapidly are the Las Posas, Merriam, Montezuma, Rincon, Diablo, and Twin Oaks. Soil series in which the avocado root rot spreads at a moderate rate are the Fallbrook, Ramona, Placentia, and Carlsbad series. Generally the rate of spread of root rot was found to be slow on the Botella, Hanford, Yolo, Vista, and Sorrento soils. The one area of Yolo soil where the spread of root rot was rapid was in a swale where irrigation water accumulated from surrounding areas.

This survey has value, not only in choosing sites for future plantings, but also is helpful where root rot has already become established. Persons planning new groves should contact their local Farm Advisor and Soil Conservation Service office to help determine which soils are best suited for avocado culture and the least favorable for root rot development. For those who already have an infestation in their groves, a knowledge of the soils that are involved and the extent or boundaries of the various soil series will help in deciding the measures to be taken to either control or retard the spread of the fungus.

Robert M. Burns is Extension Horticulture Technologist, University of California, Riverside; K. D. Gowans is Associate Soil Specialist, U. C., Davis; R. B. Harding is Associate Chemist, and G. A. Zentmyer is Plant Pathologist, U. C., Riverside.

Farm Advisors J. Beutel, Los Angeles County; C. Delphey, Ventura County; G. Goodall, Santa Barbara County; D. Gustafson, San Diego County; J. La Rue, Tulare County; M. Miller, Riverside County; and R. Puffer, San Bernardino County, were especially helpful in this survey, as have been J. Miner, G. Borst, and D. Hanson of the Soil Conservation Service.

SOIL SERIES GROUPING IN RELATION TO RATE OF SPREAD OF AVOCADO ROOT ROT

GROUPS / SOIL SERIES	RATE OF SPREAD—CLASS I (Slow)	II (Moderate)	III (Rapid)
A. Deep—Medium Texture Soils	Number of Groves		
Botella	1	1	–
Hanford	2	–	–
Mocho	2	–	–
Sorrento	4	2	–
Vista	3	3	–
Yolo	3	–	1
B. Soils with moderately dense subsoils			
Fallbrook	7	7	–
Ramona	–	3	–
C. Soils with dense clay subsoils (clay pan)			
Bonsall	–	1	2
Carlsbad	–	1	–
Las Posas	–	–	2
Merriam	–	1	1
Placentia	2	2	1
Rincon	–	2	4
Twin Oaks	–	–	1
D. Soils which are clay from the surface to a depth of 3 feet or more			
Diablo	–	–	2
Montezuma	–	3	2