California Avocado Society 1972-73 Yearbook 56: 143-145

INCIDENCE OF AVOCADO ROOT ROT IN RELATION TO EXCHANGEABLE SOIL SODIUM IN THE VICINITY OF FALLBROOK

George Borst
Soil Conservation Service, Fallbrook, Calif. (Retired)

Avocado root rot has been identified and studied in many parts of the world, and has been related to the fungus *Phytophthora cinnamomi,* in association with poor soil drainage. This relationship was first clearly established in California by Wager (15), and since has been confirmed by many other investigators, including Huberty (9), Huberty and Pillsbury (10), Crandall (5), Zentmyer and Klotz (15), and Zentmyer and Richards (16).

Surveys conducted by Burns, Goodall, and others (3, 4, 6) have indicated a field relationship between soil morphological properties and the incidence of root rot in the principal avocado producing areas of California. These authors correlated their findings with internal soil drainage or permeability, and with identified sources of infection by *P. cinnamomi.*

However, Roth (14) concluded that *P. cinnamomi* did not readily attack avocado roots unless they were mechanically injured. He found that the incidence of damage by the fungus was associated with low organic matter and microorganism population, and with high silt and clay content in the soil.

The sensitivity of avocados to sodium injury has been established by numerous investigators. Ayers (1) found that leaf burn was associated with accumulation of chloride and sodium in the leaves, even when their concentration in the soil was very low. He concluded that tolerance of avocados to sodium and chloride was lower than that of any other plant grown in the laboratory. Haas (7, 8) found, in pot experiments with Topa Topa avocado seedlings, that sodium accumulation in the leaves occurred only when the concentration of calcium in the soil was low. He also found that when sodium was supplied as sodium chloride, sodium remained largely in the roots, while chloride was concentrated mostly in the leaves. Martin and Bingham (12) found that Topa Topa avocado seedlings grew best in a soil with 4 to 6 percent exchangeable potassium, and very low exchangeable sodium. They found that growth was reduced at 4 to 7 percent exchangeable sodium, and that injury occurred above these levels.

Kadman (11) found, in experiments with avocado seedlings of different varieties that those of Mexican parentage took up greater quantities of sodium, and concentrated more sodium in the leaves, than seedlings of Guatemalan or West Indian parentage. He concluded that injury to the roots led to the breakdown of some barrier to the translocation of sodium, and that this caused a rapid movement of sodium to the stems and leaves.

Bingham and Nelson (2) conducted long-term experiments with mature Hass avocado

trees on Mexican rootstocks, under controlled conditions of sodium stress. Sodium was supplied in nutrient solution in sand cultures, and observations of sodium accumulation in leaves and roots were recorded over an 18-month period. They found that sodium accumulated in the roots, and attained a critical level before substantial amounts appeared in the leaves. They concluded that irrigation water with a sodium adsorption ratio (SAR) in excess of 4, and soils with more than 4 to 5 percent exchangeable sodium, were injurious to avocados.

Nettleton (6) and his associates conducted investigations of three principal soils on which avocados are grown in the vicinity of Fallbrook, as part of a study of their physical and chemical properties. These investigations were made in paired topographic sequences, from ridge crest to footslope positions, at sites considered representative of each of these soils. They reported a maximum of exchangeable sodium to 4 to 6 percent in the lower horizons of the Vista soils, 6 to 9 percent in the lower horizons of the Fallbrook soils, and 19 to 20 percent in the lower horizons of the Bonsall soils. The higher values in the Vista and Fallbrook soils were found at sites that had formerly been irrigated; there was very little difference in the sodium maxima in the sodium maxima in the irrigated and non-irrigated sites of the Bonsall soils. These maxima of exchangeable subsoil sodium were plotted against Burns' data, recalculated on the basis of percent of planted area affected by root rot in the vicinity of Fallbrook. * (See figure 1)

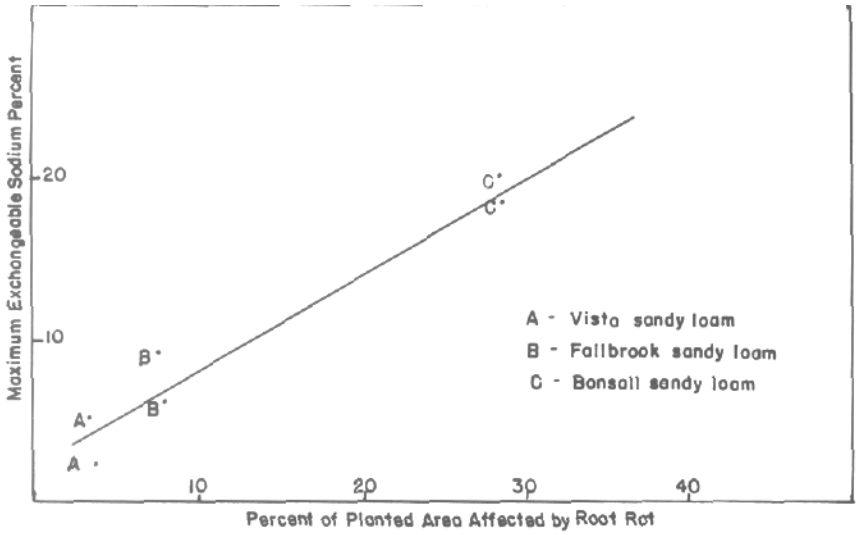

Figure 1—Relationship of maximum exchangeable sodium percentage in the subsoil to the percent of planted acreage affected by root rot in the vicinity of Fallbrook. Data from Burns (4) and Nettleton (13).

High exchangeable sodium is generally associated with a dispersal of soil colloids, and a marked reduction in soil permeability. This undoubtedly is the major factor responsible for the low permeability of the lower soil horizons in the Bonsall series. Little or no dispersal of soil colloids would be likely to occur at the levels of exchangeable sodium found in the Vista and Fallbrook soils, however, and field observations indicate that these soils are nearly always well drained and readily permeable. Nearly half of the root rot affected areas identified by Burns in the vicinity of Fallbrook were on these well-drained soils.

It would appear that injury to avocado roots by sodium accumulation may be a

significant contributing factor to the incidence of avocado root rot in the Fallbrook area. These data indicate the need for more detailed investigation of sodium distribution in avocado soils under prevailing cultural practices, and it's relation to soil microorganism populations and the pathogenicity of *P. cinnamomi.*

**The soils identified by Burns, et al as Merriam were subsequently correlated in the Bonsall series.*

LITERATURED CITED

1. Ayers, A. D. 1950. Salt tolerance of avocado trees grown in culture solutions. California Avocado Society Yearbook 35:139-148.
2. Bingham, F. T. and C. O. Nelson. 1970. The effects of sodium on mature avocado trees. California Avocado Society Yearbook 54:75-78.
3. Burns, R. M., G. Borst, C. D. Gustafson, G. A. Zentmyer, and W. A. Thorn. 1961. Escondido area avocado root rot soil survey. California Avocado Society Yearbook 45:99-103.
4. Burns, R. M, J. H. Miner, C. D. Gustafson, G.A. Zentmyer, and W. A. Thorn. I960. Correlation of soil series and avocado root rot damage In the Fallbrook area. California Avocado Society Yearbook 44:110-113.
5. Crandall, B. S. 1948. Phytophthora cinnamomi root rot of avocados under tropical conditions. Phytopathology 38:123-130.
6. Goodall, G. E, D. M. Hansen, and R. M. Burns. 1962. Santa Barbara County avocado root rot soil survey. California Avocado Society Yearbook 46:63-71.
7. Haas, A. R. C. 1950. Calcium In relation to sodium in avocado seedlings. California Avocado Society Yearbook 35:161-168.
8. Haas, A. R. C. 1950 Effect of sodium chloride on Mexican, Guatemalan, and West Indian avocado seedlings. California Avocado Society Yearbook 35:153-160.
9. Huberty, M. R. 1943. The drainage and permeability characteristics of the soils on which avocado tree decline and collapse are prevalent. California Avocado Society Yearbook 28:38-39.
10. Huberty, M. R, and A. F. Pillsbury. 1943. Solid, liquid, gaseous phase relationships of soils on which avocado trees have declined. Proceedings of the American Society for Horticultural Science 42:39-45.
11. Kadman, A. 1964. The uptake and accumulation of sodium in avocado seedlings. Proceedings of the American Society for Horticultural Science 85:179-182.
12. Martin, J. P. and F. T. Bingham. 1954. Effect of various cation ratios in soil on growth and composition of avocado seedlings. Soil Science 78(5):349-360.
13. Nettleton, W. D., K. Flach, and G. Borst. 1968. A toposequence of soils in tonalite grus in the Southern California Peninsular Range. U.S. Department of Agriculture, Soil Conservation Service, Soil Survey Investigations Report No. 21.

14. Roth, G. 1964. A study on avocado tree decline. Technical Service South Africa Department of Agriculture, Technical Communication 18.

15. Wager, V. A. 1940. The dying back of avocado trees in Southern California. California Avocado Society Yearbook 25:40-43.

16. Zentmyer, G. A. and L. J, Klotz. 1947. Phytophthora cinnamomi in relation to avocado decline. Phytopathology 37:25.

17. Zentmyer, G. A. and S. J. Richards. 1952. Pathogenicity of Phytophthora cinnamomi to avocado trees and the effect of irrigation on disease development. Phytopathology 42:35-37.