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The Drainage and Permeability Characteristics of the Soils on which Avocado Tree Decline and Collapse Are Prevalent

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Introduction: The common conclusion reached by those who have observed avocado tree decline is that it is closely associated with excessive amounts of water in the soil. While there is danger of the excess moisture being caused by the application of too much irrigation water, generally this is not true as avocado growers follow a conservative irrigation program. The real danger occurs in winter and spring during periods of high rainfall. At this time evaporation rates are low; all the soil surface is wet; drainage water from adjoining tracts, even though unirrigated, might pass into the grove; and, the depth of water falling in a single storm might exceed the total amount of water applied during a whole season of irrigation. How these large amounts of water will affect the orchard will depend in large measure upon the character of soil in the orchard.

Soil Types: Although there might be wide differences in structure and depth of soils classified in soil surveys under a particular name, all soils classified under the same name should have the same origin and mode of formation. From a physiographic point of view the soil can be classified as hill, plain, and valley soils. Classed according to the mode of formation they are known as primary and secondary soils. The former are soils formed in place from the rocks immediately below them; the latter are transported soils. The secondary soil grouping is subdivided into recent and weathered. The recent soils are found in the valleys and on alluvial fans, while the weathered soils are found normally on the low hills and plains. The weathered secondary soils have a dense subsoil which is very impervious to water. The valley soils, which usually have the most favorable soil profile, are not widely used in avocado culture because of the less favorable temperature conditions prevailing in the valleys.

Whether a primary soil will be suited to avocado culture will depend in large measure upon the depth to bedrock, or the depth to the clay pan that might overlay the bedrock. The primary soils in the Vista district are derived from granitic rock and are of two general types, the grayish brown and the reddish soil. The color normally indicates a degree of weathering, the more reddish soil usually having the heavier subsoil. In the Whittier Heights and Carpinteria districts the underlying bedrock is of sedimentary origin.

Secondary soils with permeable surface soil and dense subsoils are widely found along the coastal plains of southern California. While there are wide variations in the depth to the subsoil and in the nature of the subsoil, any grower with this type of soil should recognize the poor drainage characteristics of the soil.

Water movement through soils: In considering the moisture relation of soils we must recognize that the soil is a three phase system consisting of solid, liquid, and gas. While the volume of the solid phase is rather uniform the other two vary widely depending upon the amount of water present. The space occupied by water and air is called pore space. A coarse textured soil might have approximately the same total pore space as a fine textured soil, but the individual pores are larger and more permeable to water. Under free drainage conditions a soil is capable of holding against gravity a certain amount of water. This is normally referred to as field capacity. If water in addition to this amount is added, water will pass through and beyond the depth of soil under consideration. If any barrier to water movement exists, such as bedrock or a dense subsoil, water will accumulate in the soil and the volume of soil air will be reduced. On flat lands a general water table would be produced. The soil for some distance above the free water surface will have a high moisture content. On sloping lands the excess water moves down the slope on top of the restricting layer. If the surface soil becomes heavier, or shallower, than the soil farther up the slope, water which was flowing below the ground surface will rise and cause surface flow.

In recent years a sod covering has developed in many avocado orchards. While helpful in reducing erosion, this sod has normally increased the permeability of the surface soil.

Professor Arthur F. Pillsbury and I have conducted measurements in the field and in the laboratory on the relative rates of water movement in the surface and subsoils of some of the soils on which avocado trees are grown. Our observations showed variations in permeability between surface and subsoil of weathered secondary soils to be of the following magnitude:

(a) Ramona clay loam, Yorba Linda 290:1

(b) Merriam sandy loam, San Diego County 5500:1

(c) Los Flores loamy sand, 160:1

Prevention of excess moisture conditions: During years of high rainfall it is impractical to prevent free water from accumulating in the root zone of soils with heavy subsoils. As previously mentioned, the soil immediately above a free water surface contains a large amount of water. This condition prevents the satisfactory drainage of the soils with very shallow surface soil. However, where the soils are of reasonable depth more favorable soil moisture conditions can be maintained by the use of clean furrows, or by sub drains. The surface drains are cheaper and in some cases adequate. Tile drainage, while expensive, might be required at times to satisfactorily control soil moisture conditions.

Summary: Avocado orchards have generally been planted on hill soils which have been formed in place from the rock immediately below, or on weathered secondary soils having dense subsoils. Field and laboratory measurements show the surface soil to be normally very much more permeable to water than the subsoil. This condition causes free water to collect immediately above the dense subsoil following heavy rainfall or large applications of irrigation water. Surface drains and sub drains, or both, can be

used in reducing excessive moisture in soils of reasonable depth. It should be recognized that soils of the Merriam and Los Flores types are problem soils and not suited to general avocado culture.