L. H. Stolzy, A. W. Marsh, R. E. Puffer, and D. C. Baier

Placement of Tensiometers as guides to irrigation practices

The moisture sensing unit—a porous cup—of tensiometers must be reached by the irrigation water if the moisture measuring instruments are to be of practical value as guides to irrigation practices.

In most soils a good location for a tensiometer station is often next to the furrow, but it may be necessary to locate the porous cup under the furrow in orchard soils with little or no lateral movement of water during irrigation. In sprinkler-irrigated orchards the cup must be in soil that is re-wetted by the sprinkler at each irrigation but is not shielded by a low hanging branch nor is flooded by runoff from a branch. Also the porous cup should be in areas of active feeder roots as determined by root density studies, or by digging at different sites until a general pattern of root densities is apparent.

Some traffic between the tree rows is necessary in most orchards, so the soil moisture measuring instrument must be in a protected spot reached by irrigation water and where feeder root density is average for the tree. In general, a good location for a tensiometer is at the drip line on the tree side of the first furrow, south or west of the tree.

Usually instruments are put at two depths at each selected station. In an orchard with an average root system, a tensiometer in the 12″ – 18″ soil depth gives information on moisture availability sufficient for irrigation timing. A tensiometer with the porous cup 24″–36″ deep shows the minimum depth of soil which is re-wet at each irrigation. If the instrument does not respond following irrigation, a visual check—made by digging—will show that the water did not penetrate to the porous cup. A tensiometer placed deeper than 36″ in a citrus orchard seldom gives much functional information except in special cases, such as in a leaching program or where more than 3′ of coarse sandy soil overlies a silt layer that supplies the tree roots with a disproportionate share of moisture and nutrients.

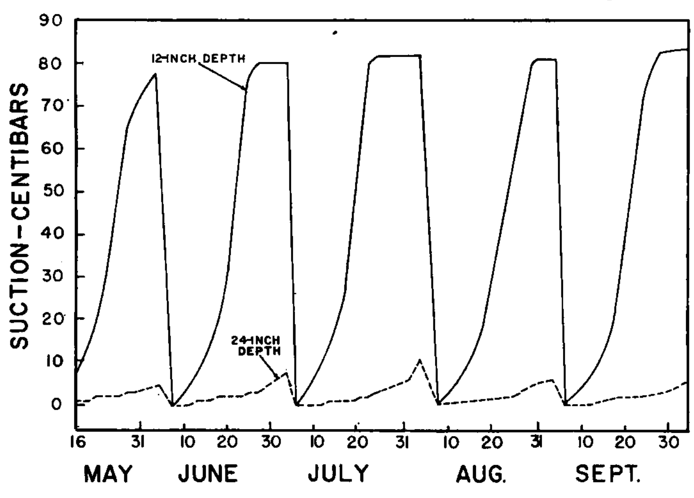
Successive readings of tensiometers—when plotted on a graph—indicate certain soil characteristics to be considered in an irrigation program. As an example, a citrus orchard on Ramona loam was on a monthly irrigation schedule with three days of water delivery for each irrigation. The graph on the left, prepared from tensiometer readings shows the soil in this part of the orchard to be very slowly permeable below the 24″ depth. Following irrigations the tensiometer at the 24″ depth registered zero readings for several days. However, some of the irrigation water eventually moved out of the 24″ depth by moving through the slowly permeable soil or by root activity. The graph on the right shows a relatively steep curve following irrigations at the 24″ depth, indicating water was moving downward through the soil as well as being used by the tree.

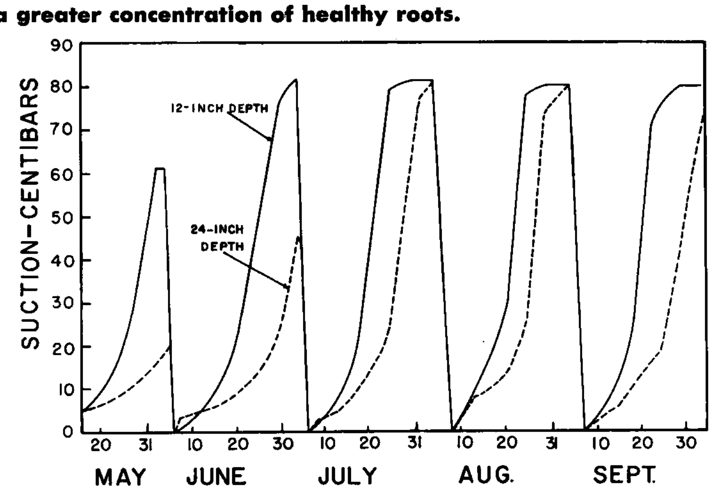
A comparison of the plotted tensiometer readings from the two stations in the orchard revealed that the 12″ depth shown in the graph to the left changed in suction values—measurement of the energy holding water in soil—more rapidly than the 12″ depth shown in the second graph. The reverse was true of the 24″ depth.

Root activity was at a minimum at the 24″ depth in the first graph, indicating that the saturated condition of the soil after each irrigation caused the roots to disappear, probably due to root rot fungi. Also, the readings showed over-irrigation during the monthly 3-day irrigation period. Furthermore, high suction values existed between irrigations for long periods during July, August, and September when moisture from winter rains had been depleted in all soil areas where roots were present, except in the irrigated soil. Where the energy holding moisture in soil is relatively strong—high suction values—in the irrigated areas, production is apt to be reduced by the moisture stress on the trees. A pipe line in the middle of this particular or-

Concluded on next page

***Left.* Soil moisture conditions in a mature navel orange orchard located on a Ramona loam soil furrow-irrigated monthly for a 3-day period. Tensiometers installed at dripline of third tree in a 36-tree irrigation run. Flat-top portions of curves caused by inability of tensiometers to read above 80 centibars, reflect a very low soil water availability. *Right.* Soil moisture conditions in the same orchard and tree row but at lower end of the irrigation run. Increased activity at the 24″ depth indicates better subsoil drainage and a greater concentration of healthy roots.**





Inadequate drainage was the cause of a soil salinity problem on 25,000 acres of Tulelake land during a five-year study of water tables and soil salinity.

The predominant crop in the Tulelake area is barley, a crop that can stand higher soil salt concentration than most other crops. However, when the salinity level exceeds four millimhos—unit of measurement of electrical conductivity of saline—a reduction in barley yield begins. At eight millimhos the yield is reduced about 20% and at 16 millimhos there is a 50% reduction in yield.

A field examination of the salinity problem in Tulelake was initiated in 1955 and during the growing season water table heights were measured by continuous recorders and observation wells. Soil samples were taken adjacent to the recorders three times during the growing season—at the start, the middle, and the end—and analyzed for total salts. Because of the limited number of sampling sites included in the study, the salinity readings are merely indicative of the general situation. Undoubtedly there are many salty areas not sampled, and some of the salty land may include areas of low salt.

Soil samples from several locations at the end of the growing season were examined to determine the vertical distribution of salt in the soil profile. One representative analysis showed a high concentration of salt in the surface soil layers. The top inch of soil contained about twice as much salt as the second half foot.

Soil samples taken at the end of the growing season clearly indicated that the salinity problems in the land studied were the result of the high water table.

JAMES N. LUTHIN AND KENNETH BAGHOTT

Soil Salinity

on Tulelake lands

Water moves upward from the water table level by capillary action to the soil surface and evaporates, leaving the salts in the soil. However, the water table must be close to the soil surface for long periods of time for the upward movement and evaporation of the water to take place. Poor soil drainage and inadequate control of irrigation water contribute to the salinity problem.

Salt Content in Surface 6″

Depth	Salt Millimhos
0″ – ½″	14.80
½″ – 1½″	14.80
1½″ – 3″	9.12
3″ – 6″	8.48
Salt Content at Same Location with ½ foot Sampling	
0″ – ½″	10.22
½″ – 1″	6.90
1″ – 1½″	6.23
1½″ – 2″	6.01
2″ – 2½″	5.32
2½″ – 3″	4.64

The following spring more soil samples were taken to determine the effect of the winter rains in soil leaching. There was considerable leaching of the salt and the average salinity was below the levels found at the start of the field examination. The amount of leaching by winter rains depends on the total seasonal rainfall, the amount of each storm, the level of the water table during the rainy season, and on the adequacy of field drains for rapid removal of water from the soil.

When the water table is close to the soil surface, the winter rains are not effective for leaching. However, when the water table is kept 4′ or 5′ below the soil surface by a system of drains, winter rains will wash out an appreciable amount of salt.

To keep the water table sufficiently below the soil surface, some sort of drainage—tile lines or open ditches—must be provided at a depth of at least 4′ and spaced close enough together to lower the water table rapidly.

Water must move through and out of the soil to get rid of the salts, so ponding water on the soil without adequate drainage accomplishes little in the way of leaching.

Flooding land lacking drainage prior to the growing season, as has been the practice for many years in the Southwest Sump of the Tulelake lands, has resulted in a continued increase in the soil salinity problem.

James N. Luthin is Associate Professor of Irrigation, University of California, Davis.

Kenneth Baghott is Farm Advisor, Modoc-Siskiyou Counties, University of California.

TENSIOMETERS

Continued from preceding page

chard would reduce the number of trees in an irrigation run and give more flexibility in the irrigation practices of the two areas. A three-week irrigation schedule with a reduced amount of water would prevent excessive saturated soil conditions and benefit the orchard.

Another orchard on Ramona sandy loam appears to have a very active root system at both the 12″ and 24″ soil depths. A slowly permeable subsoil restricts the downward movement of water and forces it to move laterally until the whole soil area around the tree is saturated. A three-week irrigation schedule with not more than 24 hours of water applied at one time would be a better irrigation program than a monthly program for a three-day period.

A third orchard—on a Hanford sandy loam—has a deep root system and root activity causes the soil suctions to increase more rapidy at the 24″ and 36″ soil depths than at the 12″ depth. Apparently some restriction in the soil between the 12″ and the 24″ depths prevents the soil suction values at the deeper depths from reaching saturation. The recovery from saturated conditions at the 12″ depth makes a favorable condition for feeder roots. Tensiometer readings indicate a good irrigation program in the orchard.

Citrus trees are conditioned by cultural practices and a shallow-rooted orchard might not stand a sudden change to longer intervals between irrigations. Citrus trees under sprinkler irrigation tend to develop root systems that are shallower than those of furrow-irrigated trees. Also, sprinkler irrigated citrus trees wilt at much lower suction values, for comparable depths, than trees under furrow irrigation.

L. H. Stolzy is Assistant Irrigation Engineer, University of California, Riverside.

A. W. Marsh is Extension Irrigation and Soil Specialist, University of California, Riverside.

R. E. Puffer is Farm Advisor, San Bernardino County, University of California.

D. C. Baier is Farm Advisor, Orange County, University of California.