Alfalfa and Water Table Levels

studies on effect of alfalfa on water table indicate need for close control of irrigation

James N. Luthin and William Bianchi

Alfalfa extracts soil-moisture uniformly to the depth of its root system, and rapidly growing alfalfa will lower the water table appreciably.

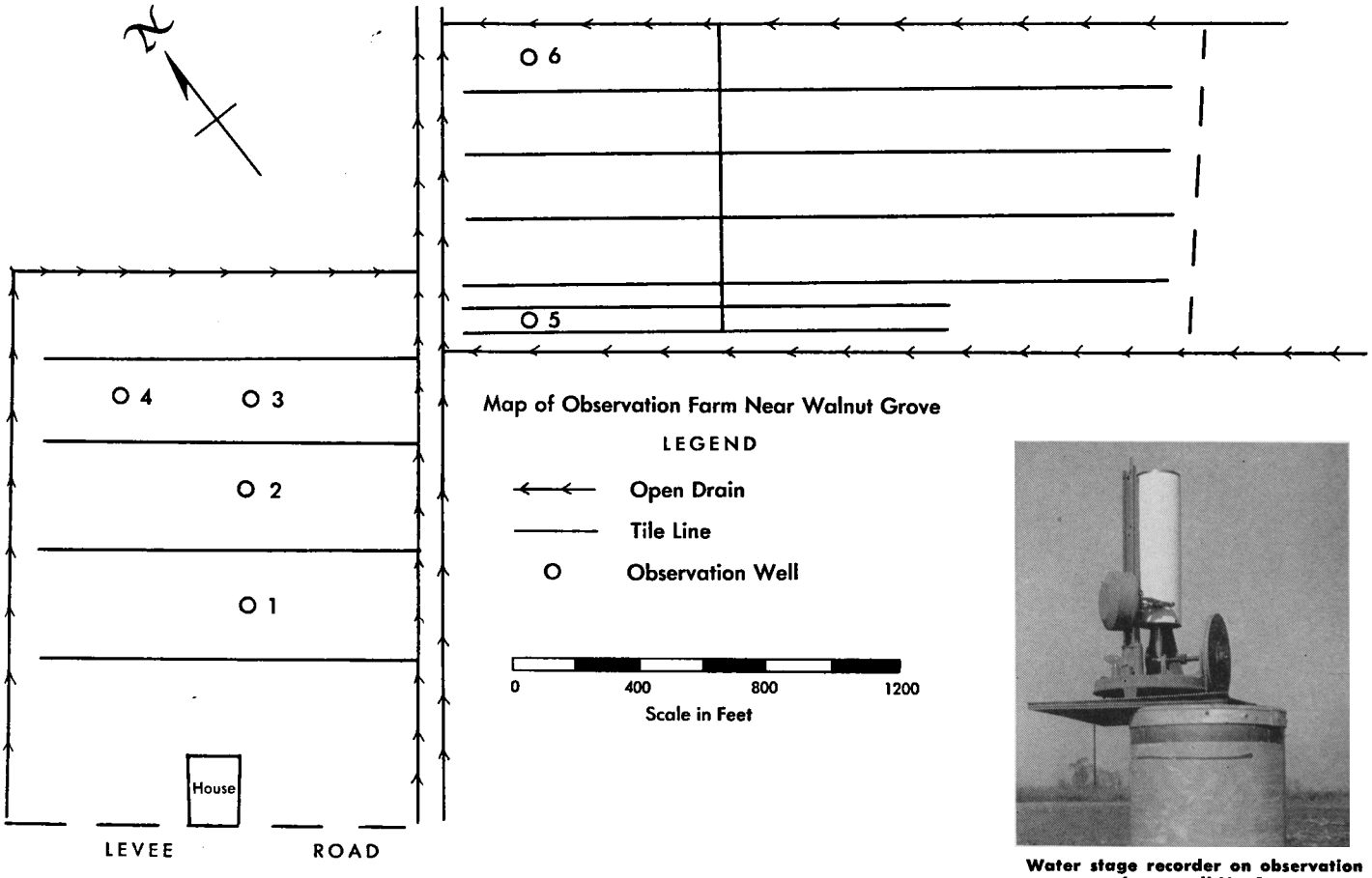
Measurements of water table conditions and of soil moisture—to examine the effect of alfalfa on the water table—were made on a farm on the east side of the Sacramento River about three miles above Walnut Grove. The farm is typical of those in that area which have a mineral soil and suffer from high water table conditions caused by seepage from the Sacramento River during high river stages.

Before a tile drainage system was installed in the fall of 1950, only part of the farm could be farmed to annual crops, and even then results were uncertain. Since installation of the drainage system, there have been good yields of alfalfa on most of the farm.

Five water stage recorders were installed on the farm. Moisture samples were taken adjacent to wells No. 1, 2, 3, 5, and 6. In addition, soil samples from the same locations were taken to the laboratory for analysis of their moisture-holding properties. The moisture equivalent of a soil is approximately equal to the amount of water the soil will retain following an irrigation. The permanent wilting percentage is the amount of water left in the soil when the plants can no longer extract any more. The moisture in the soil between the permanent wilting percentage and the moisture equivalent is readily available for plant growth. When the soil moisture reaches the permanent wilting percentage, the soil is dry—as far as the plant is concerned—even though it may retain as much as 20% of moisture, as in the case of some soils.

Water table fluctuations were traced by a water stage recorder located on the observation farm at well No. 1. At night the water table rose, because of seepage from the river, and reached its maximum height at about 8–9 a.m. River seepage also occurs during the day, but plant use or transpiration, which starts at sunrise and ends at sunset, exceeds seepage and lowers the water table. The water table on the observation farm reached its lowest position at about 6–7 p.m.

Normally there is not enough oxygen in the ground water to permit the growth of roots below the water table. The roots usually end about a foot above the water table and grow in the fringe area where water rises by capillary action. During the day the roots take the moisture from the capillary fringe. This causes moisture to rise—replacing that used by the plants—and the water table to decline.



Water stage recorder on observation farm, well No. 1.

Replacement of the fringe moisture is not instantaneous but depends on the speed with which water moves through the soil—its permeability.

After the plants cease transpiring at sunset, moisture moves up by capillary action from the water table into the fringe area and continues to do so for several hours after sunrise. As the transpiration rate increases with increasing light intensity, the rate of plant use of moisture in the capillary fringe increases. In turn, the rate of movement from the water table into the capillary fringe increases until it exceeds the seepage from the river. At this time the plants use more water than is supplied by river seepage.

Since the rate of rise of water from the water table and the rate of seepage depend on the soil permeability, water table fluctuations vary from soil to soil. A less permeable soil would be expected to exhibit greater fluctuations than a more permeable soil. In fact, if the permeability is high enough, the water table should fluctuate very little, if at all. This is approximately the case at well No. 6 on the observation farm where the soil is underlain by peat at about 30″. The water table remains relatively constant at about 20″ below the ground surface, and irrigation is not necessary.

The greatest water table fluctuations were observed at well No. 1, where there is a clay layer 6′ to 12′ below the ground surface and sand at 15′.

In the area near Walnut Grove, the level of the Sacramento River fluctuates according to the tides. The fluctuation has two peaks a day and the peaks progress at the rate of 20 minutes a day. They do not coincide with the observed peaks in the water table fluctuations which occur at the same time every day. However, the river level fluctuations do have some effect on the water table. For example, the small hump in the graph curve for September 21, 22, 23, and 24 is due to the effect of the tide on the river level.

Effect of Alfalfa Cutting

Before the alfalfa on the observation farm was cut—beginning at 3 p.m. on September 13—the daily water table fluctuations averaged about .35′ per day, and the water table was gradually declining.

On the first day after cutting, the water table rose rapidly and it was almost nine days before the transpiration rate was high enough to prevent any further rise in the water table. By September 28—15 days after cutting—the alfalfa was once again causing a steady decline of the water table. The total rise of the water table from September 13—day of cutting—to September 22 was more than .7′. Weather and river conditions remained constant during this period, so the fluctuations must properly be ascribed to the transpiration rates of the cut and uncut alfalfa.

The water table fluctuations at recorders No. 1 and No. 2 were greater than those at any other locations on the farm. At observation well No. 4, the maximum daily fluctuation was never more than .1′. The soil at this location is quite sandy, and in the past it responded rapidly to changes in the level of the river. When the river is high during the winter, this spot is one of the first to suffer from a high water table.

The area around well No. 5 is also sandy and is poorly drained even though an open ditch is close by. Because of the poor drainage, no crop was grown in the area. The water table remained constant and did not exhibit any daily fluctuations, with the exception of a period during the middle of the summer. A very sparse growth of weeds caused a daily fluctuation of about .03′ per day.

Soil Moisture Records

Records taken at well No. 1 indicate that most of the soil moisture in the root zone was gone on July 2—the date of the first sampling. Two border checks out of the field were irrigated on July 17 to learn what might be the response to irrigation. At cutting time, the irrigated checks yielded about three times as much alfalfa as the nonirrigated. The nonirrigated checks showed definite signs of injury because of drought even though the alfalfa was getting water from the capillary fringe.

Moisture Analysis of Soil Observation Farm near Walnut Grove.

Well		0–6″	6–12″	12–24″	24–36″	36–48″
#1	ME	34.3	35.2	34.4	32.9	31.7
	PWP	18.1	18.9	17.6	18.8	17.1
#2	ME	39.0	43.6	46.9	35.8	35.7
	PWP	18.2	21.6	21.3	16.6	20.1
#3	ME	44.9	43.3	34.7	30.1	...
	PWP	26.6	22.8	19.0	14.7	...
#5	ME	19.6	18.1	17.7	18.1	18.2
	PWP	9.3	8.4	8.4	7.9	8.4
#6	ME	51.3	54.9	51.7	52.2	...
	PWP	22.0	29.5	30.9	24.0	...

With the soil conditions prevailing at well No. 1, the alfalfa probably should be irrigated at each cutting during the middle of the growing season to get maximum yields.

Because of the variable soil conditions on the farm, the irrigation frequency should be adjusted to the soil type.

The effect of surface irrigation on the water table was observed in the course of the study. By careful surface irrigation it is possible to apply water without an appreciable effect on the water table.

Because the observation farm has a tile drainage system, some rise in the water table due to overirrigation is probably not serious because it drains down in a day or so. Where no underground drainage system is available, great care must be exercised in irrigation to maintain close control of the amount of water applied. A permanently cased well—to observe the effect of irrigation on the water table—is desirable. The well may consist of a section of irrigation pipe in an augered-out hole, with the bottom of the hole filled with about a foot of gravel and the sides of the pipe encased by gravel.

A permanent observation well will help a grower maintain soil moisture available to the alfalfa plant roots.

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

William Bianchi is Research Assistant in Irrigation, University of California, Davis.

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Part of water table record showing fluctuations during month of September.