

Soil Compaction by Tractors

**irrigated soils may suffer from low water penetration
limiting root development and reducing plant growth**

L. D. Doneen, D. W. Henderson, and G. V. Ferry

The soil compaction problem can not be solved quickly by short-term means; it requires preventive long-range soil management.

The problem has been recognized as serious in field crops on irrigated lands where yields depend on adequate water penetration.

Many tillage operations must be fitted into crowded farm plans, and it is important to know when such work can be performed with a minimum of compaction. As a first step in this direction, an experiment was carried out to determine the effect of passage of a tractor over the soil at various intervals of time after irrigation.

Infiltration Tests

The experiment was carried out on Hesperia sandy loam near Shafter. This location was selected because soil compaction due to tillage frequently occurs in this area on Hesperia and similar soil types. A large percentage of tillage operations are performed during seed-bed preparation and the cultivation of young row crops when drying of the soil occurs largely by evaporation. These conditions were simulated by carrying out the experiment on fallow land in late June when

evaporation from the soil surface was rapid.

The tractor used was a large row crop type equipped with 11"-38" rear tires and two 5.50"-16" front tires placed close together. Each rear wheel was equipped with a 300-pound weight and the rear tires were partly filled with water. The total weight of tractor and driver was 5,200 pounds of which approximately 80% was borne by the rear wheels. There was no draft on the tractor when it was passed over the experimental plots.

The experimental area was irrigated June 16, and the tractor was driven over different portions of plots two, six, and 12 times—passes—at successive later dates—June 18, 20, 23, 28, and July 5. On the dates of tractor passes soil moisture samples were taken in 3" increments to a depth of 12" and in 6" depths from 12" to 24".

On July 22 the plots were again irrigated and infiltration rates were determined July 23 and 24. These studies were made on a moist soil—field capacity—which eliminates some of the variability occurring naturally in dry soils. A total of 12 infiltration tests were made in the tracks of the rear wheels of the tractor, six in the tracks of the front wheels, and

18 tests were made outside of the tracks for checks.

Results

Infiltration rates were the same in front and rear wheel tracks. Apparently the smaller bearing surface of the front wheels resulted in pressures comparable to that exerted by the rear wheels. Infiltration rates for front and rear wheel tracks were combined giving an average of 18 tests for the tractor tracks for each date and series of passes.

As the right diagram on page 8 indicates, the reduction in rate of water infiltration is governed by the number of passes made by the tractor. Even two passes soon after irrigation markedly reduced the infiltration rate. Little is gained by delaying tillage operations more than seven days after irrigation under these soil and climatic conditions, even though there is a significant reduction in infiltration rate after 19 days for all treatments.

There is no significant difference in the effects of six and 12 passes at any date, although both these treatments resulted in significantly greater reduction than two passes throughout the experimental period.

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Cotton field on Hesperia sandy loam. The right half of the field was chiseled to a depth of 20" and yielded two bales of cotton. The unchiseled half on the left yielded a half bale and had considerable growth of water grass. This poor yield was due to the poor penetration of irrigation water which stood in the furrows for long periods after irrigation.



COMPACTION

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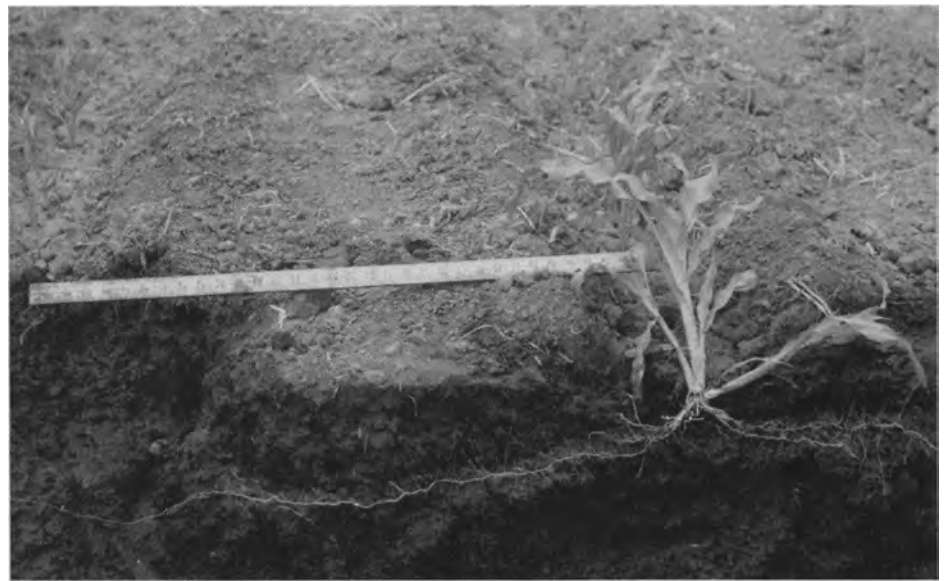
The relationship between the infiltration rate and the soil moisture content at the time of the tractor passes is presented in the left diagram on this page. The moisture content of the surface 6" was used because this was the depth in which surface evaporation occurred. Below this depth, the soil moisture was near field capacity.

The relationship is approximately linear from a moisture content slightly above the moisture equivalent to a moisture content approximating the wilting percentage—a wide range. These data are in agreement with soil mechanics findings which indicate that compression of a soil under a given load increases with increasing moisture content up to a point somewhat below saturation of the compressed soil.

The moisture content of maximum compaction was not approached in this experiment. The relatively small changes in infiltration rate near the end of the experimental period were caused by slow drying of the soil at that time.

Core samples were taken with an especially constructed sampler which could secure undisturbed soil samples.

Volume weights of these cores and examination of the soil in the field indicated that the compression of soil by the tractor tires was apparently limited to a depth of about 7" under the severest treatments—six and 12 passes at two and four days after irrigation—and that the depth affected was somewhat less with the drier



Corn roots unable to penetrate the dense layer of compact subsoil under cultivated surface soil in Yolo clay loam.

soil. However, neither method of determining the depth affected is sufficiently sensitive to indicate changes which would be relatively large as measured by water infiltration.

Had there been a draft on the tractor, compaction might have been more severe due to slippage of the wheels. Any soil working equipment such as chisel, disk, or plow, would have partly destroyed the surface compaction and minimized the effect on infiltration.

Continually working wet land will cause a general compaction to a depth of 18" or more. However, under condi-

tions similar to those of this experiment, the soil should not be tilled for as long as possible after wetting by rains or irrigation, and the tillage operations or number of passes over a field should be kept to a minimum.

L. D. Doneen is Lecturer in Irrigation, University of California College of Agriculture, Davis.

D. W. Henderson is Instructor in Irrigation, University of California College of Agriculture, Davis.

G. V. Ferry is Farm Advisor, Kern County, University of California College of Agriculture.

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Left, infiltration rate in tracks of a wheel tractor passing over the soil at various dates after irrigation. Passes—the number of times the tractor moved over the plot in the same tracks. Right, infiltration rates in tractor tracks in relation to soil moisture content at the time of tractor passes.

