Traffic-induced Compaction

inexpensive and relatively easy to use new soil penetrometer enables measurement of variations in degree of compaction

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Cultural methods used in modern commercial vegetable production involve operations—many passes over the field of tillage and harvesting machinery—that are conducive to soil compaction. The harvesting operations of some crops —especially celery, lettuce and spinach —are often carried out when soil moisture content is at a level at which severe compaction can occur.

One problem in studies of soil compaction is to measure the degree of compaction objectively. Several direct methods of measurement—bulk density, pore size distribution, air and water permeability determinations, and aggregate stability analysis—are used. A soil penetrometer was constructed to measure soil compaction. The instrument was made of a 3/8″ polished stainless-steel rod 4′ long. A stop was welded 2½′ from the bottom end, and a six-pound cylindrical weight with a hole ½″ in diameter was slipped over the upper end of the rod. A second stop was placed on the rod with a setscrew, so that the dropping height can be varied up to 1½′. The point was sharpened at an angle of 45°.

A 3×3 factorial design consisting of three compaction treatments, each replicated three times, was adopted for a test plot on Yolo fine sandy loam at Davis.

The main compaction plots were each split into four subplots. Four different cover crops had been planted on these plots for two previous winters, and a tomato crop harvested each summer. After the third pick of tomatoes, in early October, 1958, the plots were plowed to a depth of 10″. About 1½″ of water was applied to wet the soil sufficiently to obtain compaction.

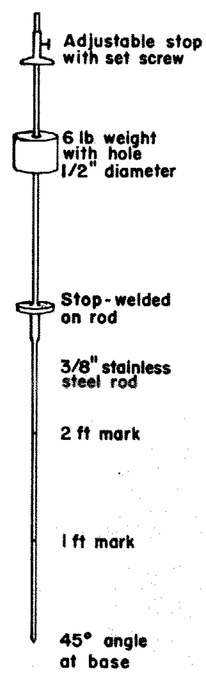

Diagram of a soil penetrometer.

Severe traffic-induced soil compaction was created by operating a two-ton truck loaded with 800 gallons of water —total weight, 10,000 pounds — over the plots. After each trip, the truck was moved aside by the width of the rear wheels until the entire plot was covered. The first two passes required towing by a track-type tractor. The truck made the next five passes unassisted. The track-type tractor was operated over the plots a total of seven times, and the loaded truck seven times. This procedure, while severe, is not uncommon in harvesting some vegetable crops, such as celery, lettuce, and spinach.

Moderately compacted plots were prepared by passing the same truck over the plots twice, followed each time by the tractor.

No truck or tractor traffic was allowed on the noncompacted—check—plots.

Immediately after compaction, soil densities were determined at the surface —0–3 centimeters—and 6″ and 12″ depths.

Five penetrometer determinations were taken and averaged from each plot. The determinations were made by dropping the six-pound weight from a distance of 1′ and counting the number of strokes required to cause the rod to penetrate the soil 1′. The rod was then driven into the soil the second foot and the number of strokes counted.

Soil moisture samples—foot-long cores —taken separately from the first and second foot, near the places where the penetrometer was driven, were not significantly different. Correlation coefficients were calculated between soil moisture and number of blows required to drive the penetrometer 1′ and 2′. The correlation was not significant over the moisture ranges existing at the time of measurement. However, a graph showing

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Some Physical Changes in Yolo Fine Sandy Loam Caused by Traffic-Induced Compaction, Davis, 1958

	Compaction		
	None	Moderate	Severe
Percent moisture (0″–6″)	20.7	19.6	19.3
Clod population (0″–6″) (lbs/100 lbs)	3.3	27.9	37.7
Clod density (gm/cc)	1.65	1.76	1.85
Soil density (gm/cc)			
Surface	1.25	1.60	1.63
6″ depth	1.48	1.55	1.58
12″ depth	1.50	1.50	1.55

Penetrometer Readings on Yolo Fine Sandy Loam, Davis, 1958

	Compaction			
	None	Moderate	Severe	LSD* (99:1)
Av. no. strokes**				
1′	3.9	8.1	10.0	6.0
2′	21.8	28.4	33.8	7.0
Soil moisture				
1′	19.9	18.9	19.8	N.S.
2′	23.3	23.2	24.0	N.S.

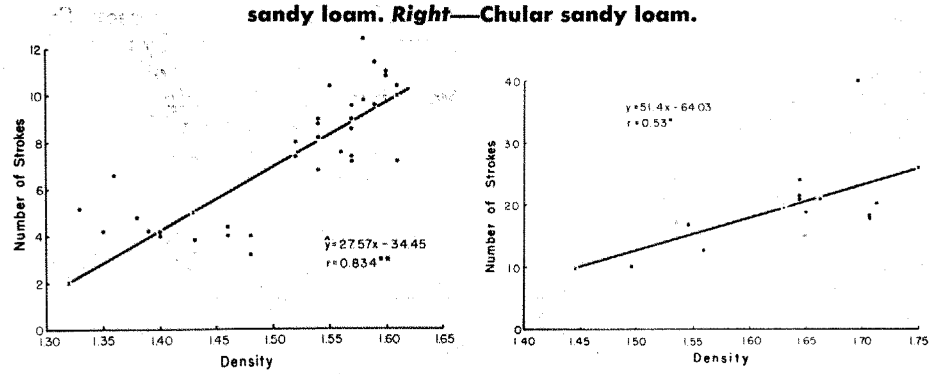
* Least significant difference.
** Each figure is an average of 60 readings.

A Comparison of Penetrometer Strokes Between Plots Without and With Ryegrass as Winter Cover Crop, Tracy, 1958

	Ryegrass	Check	LSD* (19:1)
First foot**	32.6	48.3	N.S.
Second foot	57.7	88.7	9.4

* Least significant difference.
** Each figure is an average of 30 determinations.

Correlation between soil density and number of strokes. *Left*—Yolo fine sandy loam. *Right*—Chular sandy loam.



BEANS

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pods are present. Normally, young pods are present on the plant before treatment is necessary. It is advantageous, if at all possible, to delay treatment until the presence of young lygus nymphs indicates that the eggs are hatching because the eggs are not affected by insecticides.

In the absence of field sampling, DDT or toxaphene dust applied thoroughly, usually will be adequate to protect the beans against the corn earworm and the lygus bug. Such treatments should be applied to Sutter Pinks between 40–45 days after planting; to Standard Pinks, 45–50 days and to California Reds, 50–55 days. After treatment the fields should be checked for adequacy of control and possible reinfestation prior to harvest.

Mites and leaf miners may occur in numbers sufficient to warrant suppressive measures, but generally are not too serious on pinks.

Many problems still remain to be answered but a careful grower can cope with bean insect and mite problems, and increase bean yield and quality.

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PENETROMETER

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the individual points suggested that the correlation probably would have been greater if the soil moisture range had been greater.

Differences between compaction treatments were highly significant. Penetrating compacted plots took 2½ times as many blows as penetrating noncompacted plots to an equal depth. When correlation coefficients were calculated, a highly significant positive correlation was found.

Two passes with the truck produced a compaction almost as severe as that caused by seven passes, probably because soil moisture content was near optimum for compaction. From bulk-density data it is apparent that compaction was greater in the surface foot of soil than in the second foot.

To study further the possibility of using a soil penetrometer to indicate a compacted soil condition, measurements were made on Chular sandy loam near Soledad. Soil-density core samples were extracted from the 6″, 12″, and 24″ depths. Soil moisture determinations were also made on the samples. The penetrometer was then driven 1′ and 2′ in five different locations around the area where density samples were removed. The density data and the five penetrometer measurements were averaged independently. Correlation between soil density and number of strokes required was again significant. Correlation with soil moisture was not significant at the rather narrow range existing at the time measurements were made.

Measurements were made at a third location on Sorrento clay soil near Tracy. In this study the penetrometer was used to estimate differences in soil compaction on plots on which ryegrass had been used as a winter cover crop. Plots, replicated three times, had been seeded to ryegrass the previous fall, and plowed under in the spring of 1958. The plots were then planted to tomatoes. Penetrometer measurements were made late in October, after the tomato crop was harvested. Differences were not significant in the first foot, but were significant in the second foot.

Results of these studies indicate that, under a given set of soil conditions, the penetrometer can be used to measure traffic-induced compaction. Furthermore, the pentrometer is relatively easy to use, no costly equipment is required, the data are immediately available, and samples need not be taken into the laboratory for analysis.

Variation in individual readings is considerable but the penetrometer will measure variations in degree of compaction. A large number of readings must be made for statistically valid data, but they are relatively easy to obtain.

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IRRIGATION

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water toll component on area, usually the area irrigated by district water. Area tolls may be the same for all crops or may differ among them.

In planning agricultural production a district member faces the unavoidable fixed annual assessment. However, the water toll charge is variable, depending upon the quantity used.

An important characteristic of the payment complex is that neither of the components are determined by usual market forces. Both are administratively established by the board of directors of each irrigation district. This permits the payment complex to be used as a tool in connection with many district activities: to allocate the district's supply of water among uses and users, to finance district operations, and to implement programs of water management.

The payment complex has undergone considerable variation, both over time and among different districts. Changes in the district assessment may be seen by considering its three determinants: the area assessed within a district, its valuation for assessment purposes, and the rate of levy that is applied.

Between 70% and 80% of the gross district acreage in California has been subject to assessment since official state records were published in 1929. The percentage of assessed acreage fell off through the depression years but since 1942 there has been a gradual annual increase. Prior to 1940 land held under tax default deed by California irrigation districts materially reduced the area susceptible to assessment. Such tax held land amounted to 10% of the gross district acreage for the years 1935–1937.

The second determinant of the assessment component has shown an increase —in terms of both total assessed valuation and average per acre assessed valuation—during 1930–1956 period. The per acre average valuation for all irrigation districts in 1938 represented the low—less than $60.00 per acre—as opposed to a high in 1956 of $95.00. Different methods are used in valuing lands for district assessment, which results in considerable variation between districts. For example, in 1955, districts in the Sacramento Valley had an average per acre assessed valuation of $179.00, while the average was $100.00 for districts in the San Joaquin Valley, and districts in the South Coastal Plain averaged $643.00 per acre.

The rate of assessment levy—expressed in terms of dollars assessed per $100.00 of valuation—shows less variation. The average rate of levy throughout the state has decreased from $5.00 in 1930 to a low of $2.50 in 1940, and subsequently increased to slightly over $3.00 in 1955. Its difference between geographical regions also has been small. In 1955 Sacramento Valley districts averaged $2.91, those in the San Joaquin Valley, $3.58, and the Southern Coastal Plain, $3.91 per $100.00 valuation.

The water toll element of the payment complex also has undergone change. Because of the various bases used for the toll element, no direct statewide comparison is possible. However, receipts from district water sales give some indication. In 1930, water sales receipts from all districts comprised less than 25% of total district receipts but in 1955 this had increased to over 60%.

There is considerable difference in the relative importance of the water toll component of the payment complex between types of district. Districts engag-