Orchard Plow-Pans

obstacle to root distribution and water penetration can be reduced

E. L. Proebsting

Effects of a plow-pan in an orchard—interference with normal distribution of tree roots and with the rate of water penetration into the deeper soil layers—can be counteracted to a considerable degree by a soil management program.

A compacted layer of soil—the plow-pan—usually 6″–12″ thick, lies below the depth of cultivation in many California orchards and is the result of the action of plows or disks.

Plow-pans have developed in many soils prior to the planting of orchards. The orchard comprising the covercrop experimental block on the Davis campus was planted on land that had been in grain most of the preceding 60 or more years. The plow-pan was so well developed that portions of it were taken to Berkeley for class instruction by the Soils Department.

From time to time, since the covercrop experiments were started in the Davis orchard—1924—it was reported that the plow-pan condition had improved. Also it was reported that an improvement in water penetration had been noted in the plots which have been clean cultivated continuously. A study, in the fall of 1952, to determine apparent soil density in the plots in this block detected no significant differences in this property with the possible exception that in the Melilotus indica plot the apparent density seemed less than the others. In the clean cultivated plots, good practice—waiting until a satisfactory moisture content was reached—has corrected the plow-pan condition.

Another study which points in the same direction was made in 1951–1952 to determine root distribution under clean cultivation and under non-cultivation where weed growth had been prevented by sprays.

Results

No roots were found in the surface layer of soil in the cultivated area of a Gaume peach orchard in Sutter County, which would naturally follow their destruction by cultivation. There were very few roots in the 6″–12″ layer, which had not been disturbed. Complete permeation by roots had occurred in the second foot of soil which is a Gridley loam. In contrast, the soil in the area which had not been cultivated for seven years was well supplied with roots below about 2″. Measurement of soil samples from these two plots showed apparent density—in the 6″–12″ layer—of 1.44 in the cultivated plot and 1.28 in the non-cultivated area. Although the greater density in the cultivated plot was not enough to exclude roots, it may have been dense enough to reduce their frequency.

It was noted that after a fall rain of about 4″, penetration was only about 12″ in the cultivated soil whereas it was over 24″ in the non-cultivated soil. Assuming that texture and residual moisture were comparable in the adjacent areas, and that one inch of water would bring five or six inches of soil from the wilting percentage to field capacity, all of the rain penetrated in the non-cultivated plot while about half of it was lost from the tilled surface.

Data were obtained from two almond orchards, both on Yolo loam, in the Capay Valley in Yolo County. Root distribution followed the same pattern as the Gaume peaches in the Sutter County study. There was no surface rooting and few roots were in the 6″–12″ layer in the cultivated area but there were roots throughout the entire soil profile below about 2″ in the non-cultivated plots. Apparent soil densities in one orchard were 1.76 in the cultivated area and 1.56 in the non-cultivated area. In the second orchard they were 1.66 in the cultivated and 1.19 in the non-cultivated areas. The 1.76 figure is in the range considered too dense to permit root growth or water extraction.

An olive orchard sampled in Glenn County on San Joaquin loam showed greater soil variability, but the rooting habit followed the same pattern. The apparent density measurements gave values of 1.60 in the cultivated and 1.43 in the non-cultivated.

Root distribution in a nectarine orchard in Tulare on a Tujunga sandy loam again showed the same contrast as the ones above. This orchard had plots in which the differential treatment had continued for eight years. It seemed to the eye that the trees in the non-cultivated area were the larger, but trunk circumference measurements gave the values: 23.6 ± .48″ for the cultivated and 25.4 ± .59″ for the non-cultivated areas, a difference which is not significant, although in the direction expected.

A Santa Rosa plum orchard in Tulare County on San Joaquin loam did not have a cultivated check for comparison. Roots were well distributed and soil samples were taken from an adjacent cultivated fig orchard for comparison. The apparent densities were 1.66 in the cultivated and 1.53 in the non-cultivated or-

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whether this can be done on a sound economic basis because the present methods require much hand work which increases man-hours to a point where a mass culture program for parasites would be impracticable. For example, the male parasites must be removed from the presence of the females and held isolated for a period of six or seven days before they can successfully mate with newly emerged females.

When the insect rearing laboratory was set up most of the flies used as test insects were obtained from field sources by trapping them in the heavily populated wild guava areas or by rearing them out of heavily infested fruits brought into the laboratory.

The California laboratory developed and amplified the culture of the oriental fruit fly to a point where it was able to supply over five million of this species to the Federal agency alone for test purposes. This species was more desirable for experimental work than the former field flies since they were well standardized, age-dated and had been reared on a common medium.

Anticipating the possible accidental introduction of the oriental fruit fly, the State of California has, through the work done in Hawaii, gained two years against the time of the pest's arrival.

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The study of adult fly nutrition was done by Kenneth S. Hagan, Junior Entomologist, University of California, Albany, California. The studies of larval nutrition and associated microorganisms were done by Shizuko Maeda, United States Department of Agriculture, Hawaii.

Commercially Grown Carnations

studies in soil fertility control made to determine optimum fertilization for production of ornamentals

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Soil testing for fertility control in carnation production showed that large quantities of nitrogen and of potassium are removed from the soil—by plant absorption or through leaching—when cultural methods for bench grown carnations are typical of those in use in the San Francisco Bay Area.

The merits of soil testing as a control for maintaining an abundant supply of nutrients for cut-flower production were investigated in greenhouse studies.

White Sim's carnations were transplanted into small plots—with an area of about 10 square feet—on August 8, 1951 in two commercial greenhouses, on the west side of San Francisco Bay.

The plots at greenhouse *A* were replicated four times on a clay adobe soil of the Dublin series into which about 15% peat by volume had been incorporated. The plots at greenhouse *B* were replicated twice on a soil mix consisting of seven parts by volume of loamy sand, three parts of peat moss and two parts of crushed stone.

The soil mix at greenhouse *A* had an exchange capacity of 38 m.e.—milliequivalents—per 100 grams and at greenhouse *B* it was 20 m.e. per 100 grams.

At both locations the phosphorus, as single superphosphate, was incorporated prior to transplanting. Gypsum also was applied to bring the level in all plots equivalent to that of the high phosphorus plots. Potassium and nitrogen were applied as sulphates about three weeks after transplanting.

Differential rates of nitrogen were applied again in November and at monthly intervals beginning in February 1952. The highest level of nitrogen received a total of 2.6 pounds per 100 square feet during a period of nine months.

Yield records were kept from the time blooming started in November 1951 until May 8, 1952 at greenhouse *A* and until May 14, 1952 at greenhouse *B*. The flowers were graded into No. 1 and No. 2 grades. Soil samples were taken at irregular intervals.

The yields of No. 1 carnations obtained at the two locations showed a large response to nitrogen. The yield of blooms of the plots receiving an average of about .3 pound of nitrogen per 100 square feet per month was significantly better than that obtained on the plots treated with .15 pound per 100 square feet per month.

There were no significant differences due to the phosphorus treatments at either location nor was there any response to potassium at greenhouse *A*. However, at greenhouse *B* the responses from the plots receiving .125, .5, and 2.0 pounds of potassium per 100 square feet were significantly better than the plot not treated with potassium. The treatments did not meaningfully affect the percentage of blooms graded No. 2.

The nitrogen determinations showed rapid fluctuations and indicated that when soluble sources of nitrogen are used applications of nitrogen fertilizers should be made at about monthly intervals.

In spite of low phosphate readings in the plots receiving no phosphorus fertilizer, yields were not affected. Soil tests also indicated that if values of pH—the acidity-alkalinity ratio—do not become too acid an application of five pounds of single superphosphate per 100 square feet will maintain adequate amounts of soluble phosphorus for almost a year.

The pH of the soil measured slightly acid, about 5.4—pH 7 is neutral—during most of the growing season at greenhouse *A* but dropped to about 4.6 at the time the last soil samples were taken. This may account for the rapid drop in water soluble phosphorus. The pH of the soil at greenhouse *B* remained between six and seven during the experiment.

The rapid depletion of nitrogen and potassium plus the uncertainty of interpretation of potassium values when appreciable quantities of non-exchangeable potassium are present militate against the use of periodic soil tests for fertility control.

When carnations are grown under conditions similar to those of these studies, it is evident that monthly applications of from .25 to .40 pound nitrogen; quarterly applications of .15 to .25 pound potash—K_2O—and annual applications of one pound of phosphoric acid—P_2O_5—per 100 square feet will meet the needs for these elements and obviate the need for soil testing.

The rates and frequency of application may have to be modified somewhat according to soil texture, sandy soils receiving more frequent and lighter applications of fertilizers than clay soils.

Most varieties of carnations are very tolerant to saline conditions but soil testing to indicate the level of soluble salts is recommended because quality and yields of carnations are often reduced by salinity conditions resulting from overfertilization or improper irrigation practices.

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chards. The root distribution pattern of citrus trees was examined in several groves in San Bernardino County, some of which had been under the non-cultivation system for many years. The soil was well explored below about 2″ in contrast to near-by groves in clean cultivation. These groves were on soil too loose for apparent soil density measurements.

It would appear from the observations obtained in this series of studies that tree root distribution can be modified markedly by the soil management program and that the effects of soil compaction by tillage equipment can be counteracted to a considerable degree. The use of cover-crops or non-cultivation may bring rapid improvement. Clean cultivation need not develop plow-pan if care is exercised as to moisture content of the soil when it is worked.

There is some evidence from leaf analyses that the better root distribution has enabled the trees to absorb additional nutrients, which might be a factor of importance for orchards located on shallow soils.

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The apparent soil density determinations at Davis were made by senior student Walter Gamboni, and the root distribution and apparent soil density study at other locations were conducted by graduate student T. C. Tomich, under the direction of Professor Proebsting.