SOIL PROFILE STUDIES Aid Water Management For Salinity Control

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LEACHING of soluble salts—necessary for sustained irrigated agriculture—is accomplished by allowing some surface applied water to pass completely through the crop root zone. Although leaching is often carried out to a limited degree with each application of irrigation water, it is sometimes only possible to leach annually or less frequently, depending upon the crop grown, water supply and other local conditions.

The recommended quantity of water to apply to reduce salinity to tolerable levels has often been based upon leaching experiments involving the continuous ponding of water over an uncropped surface. A commonly used "rule of thumb" is to apply one foot of water for each foot of soil that is to be leached. Little, if any, consideration has been given to merely redistributing the salts within the profile relative to the plant root distribution—or to leaching patterns obtained from water application methods other than ponding.

Leaching management

It is now becoming more evident that the degree of leaching accomplished at various depths within the soil profile can be significantly altered through different water management practices. These management practices may be simple, economical and easily followed with the prevailing cropping practices. This experiment to study better water management practices in relation to salinity control was conducted at the West Side Field Station, Fresno County.

A level, 1-acre site of Panoche clay loam was divided into 0.01-acre plots delineated by plastic levees. Treatments were completely randomized within five complete blocks. Potassium chloride was applied on the surface at the rate of 150 lbs per plot. The manner in which this applied salt was leached and redistributed through the profile was observed for several methods of water application. The comparison made here is between two methods only: (1) continuous ponding of the soil surface with water until the applied salt was leached through the 5-ft profile; and (2) intermittent applications of ponded water that allowed the profile to be leached at lower soil water contents. The plots were free of vegetation and without cover.

Tensiometers

Within each treatment, soil water tensiometers were located at depths of 1, 2, 3, 4 and 5 feet. Also at those same depths, porous ceramic cups were located near the tensiometers. Samples of the soil solution were obtained by applying vacuum to the porous cups, and these samples were analyzed for chloride concentration by titration. Measurements of soil water and salt content at each depth were taken every hour when water was being applied to the surface. Sampling was less frequent during the drainage periods of the intermittent ponding treatment. For each treatment a total of at least 3,500 samples were taken.

For the continuously ponded treatment, 40 inches of water were applied in approximately a week with the final infiltration rate being less than 0.2 inch per hour. The intermittent ponding treatment was carried out with an initial 4-inch application of water followed two weeks later by successive 2-inch applications. Two inches of water was applied whenever the soil tension reached 150 millibars (corresponds to 30.4% water on a volume basis) at the 1-ft depth. This value was usually reached within six or seven days after the previous irrigation. A total of 26 inches of water was applied, using intermittent ponding. The average water content of the soil in this treatment was generally about 6% less than that for the ponded treatment.

Salt movement

The manner in which the applied salt moved through the 60-inch profile, when the soil surface was continuously ponded, is shown in figure 1. The numbers on each curve refer to the depth of water (in inches) penetrating the soil surface. After 4 inches of water penetrated the surface, the salt resided within the top 2 ft of soil with the concentrations at 24, 36, 48 and 60 inches remaining very low by comparison. As the applied salt was leached through the profile, its maximum concentration was decreased while its distribution widened with depth. By the time 40 inches of water entered the surface, the salt distribution centered on the 60-inch depth with a maximum concentration of about 50 milliequivalents per liter.

Leaching during intermittent ponding was markedly different. Concentration curves for intermittent ponding, given in fig. 2, may be compared with those for continuous ponding for equal quantities of irrigation water. For the ponded condition, 6 inches of water reduced the salinity in the top 2 feet of soil little more than did 4 inches of water. When the soil was leached intermittently with 4 inches of water, and then an additional 2 inches two weeks later, a substantial quantity of salt was removed from the upper profile and redistributed within the 24- to 48-inch depth. After 6 inches of water had been applied, the concentration in the top foot of soil was 190 and 100 milliequivalents per liter for continuous and intermittent ponding, respectively.

After continuously leaching with 10 inches of water, some salt moved into all depths of the profile, but a major portion of the applied salt was left in the top 30 inches with the concentration at 12 inches being 120 milliequivalents per liter. The concentration at the 12-inch depth for 10 inches of intermittent ponded water was less than 40 milliequivalents per liter, with the remainder of the curve indicating that the center of the salt distribution moved to nearly 36 inches.

For 20 inches of applied water at the 12-inch depth, the concentration is three times less for intermittent ponding than that for continuous ponding. Comparing the treatments in the same order, the greatest concentrations were found at 48 and 38 inches, respectively.

The concentration of salt at all soil depths down to 54 inches was reduced to lower values with 26 inches of intermittently ponded irrigation water than with 40 inches of continuously ponded water. This difference would be still greater if the amounts of water lost during and between pondings by evaporation were taken into account. Except near the surface, higher maximum concentrations were found in the plots ponded only intermittently. The continuously ponded treatment caused the salt to be spread through a greater depth of soil before being leached out of the profile.

Additional trials are being conducted and future experiments which include water used by a transpiring crop will be considered. More attention must be given to the water-conducting properties at each soil depth, relative to the rate and quantity of water movement through the profile—versus that lost by evapotranspiration. Such studies will not only aid in the control of soil salinity, but will yield valuable information regarding fertilizer recommendations in relation to irrigated agriculture.

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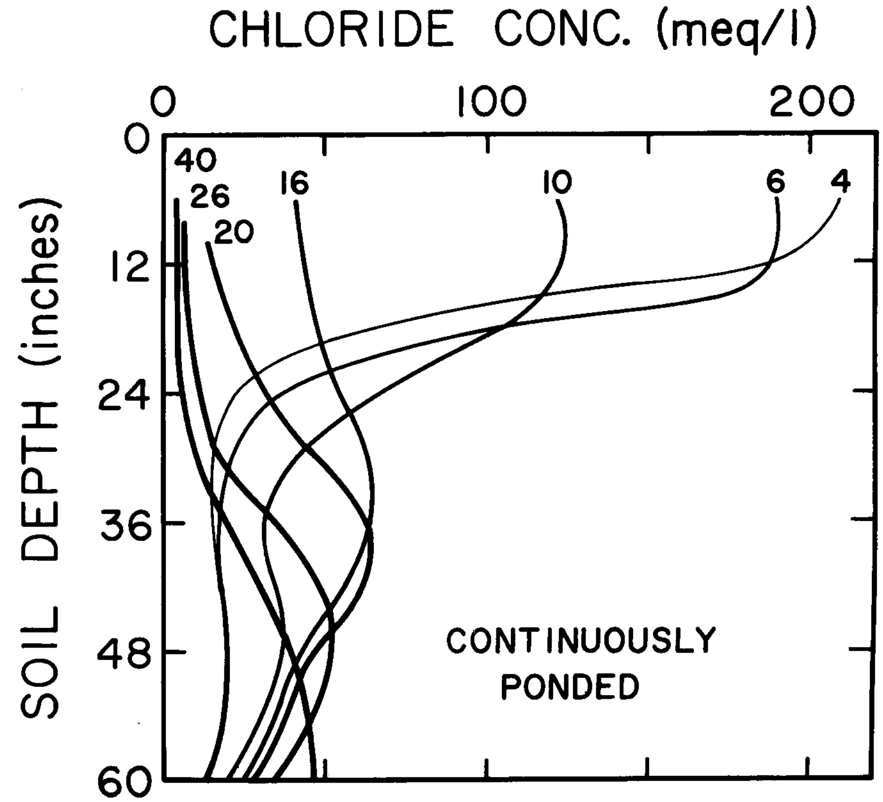

FIGURE 1—Concentration distributions of chloride in the soil solution of Panoche clay loam when the soil surface was continuously ponded with irrigation water. Numbers near the top of each curve represent the depth of water in inches that had penetrated the soil surface at the time of measurement.

FIGURE 2—Concentration distributions of chloride in the soil solution of Panoche clay loam when the soil surface was intermittently ponded with irrigation water. The numbers near the top of each curve represent the depth of water in inches that had penetrated the soil surface at the time of measurement. For example, the 10-inch curve data was obtained in four successive applications of water in the amounts of 4, 2, 2, and 2 inches.