



Extraction of deep soil solutions, following a barley crop on land where cannery effluent had been used for irrigation in Stanislaus County. Tests were made in cooperation with Tri-Valley Growers.

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THE FOOD PROCESSING INDUSTRY in California uses large quantities of water, most of which becomes waste. The water contains some nutrients, such as nitrogen and phosphorus and minor elements, plus an increased salt load of two to three times that of the original water.

Using cannery waste water for irrigation and for some recharging of ground water is a new art and at present appears to be feasible and nondegrading to the environment. But continued monitoring is needed to measure long-term effects, especially crop uptake of nutrients, and solubilization of salts and minerals into ground water.

In 1971, an experiment was begun which monitors the effects of irrigating over 100 acres of cereal grains and grapes with waste water from Tri-Valley Growers' Plant No. 2, in Stanislaus County near the center of the San Joaquin Valley. The processing of many local fruits and vegetables at the experimental site produces up to three million gallons a day of waste water. This water is of relatively good quality and can be processed as municipal waste, or reused in agriculture, in which case the excess over plant use is infiltrated into the ground

CANNERY WASTE WATER

for irrigation and ground water recharging

water. The available well water for food processing contains about 300 mg/l (ppm) total salt; the waste water averages 700 mg/l, which is of sufficiently good quality for many crops.

Well water was analyzed periodically within a half-mile radius of the plant site, including industrial, agricultural and domestic wells. Soil analyses from six sites on the 100 acres were taken before and after each cropping season. Nitrogen and phosphorus levels were determined, as were levels of soluble salts, including sodium, calcium and chlorides.

Soil solutions were extracted after each irrigation and at the end of the crop season by means of porous ceramic cups. The tensiometer-type cups were located near soil sampling sites, to a depth of nearly 20 ft. It is believed the soil solutions extracted by the porous cups give a reliable measure of what elements crops will adsorb and what solutions pass through the soil. The ceramic cups also measure the soil's ability to adsorb and precipitate some elements.

Well water near the experimental irrigation trial did not show any change during the first three years of the experiment. The surface soil showed a relatively high nitrate-nitrogen ($\text{NO}_3\text{-N}$) and a total salinity increase (EC_e) following the irrigation with cannery water. After the application of waste water, the nitrate-nitrogen level was 46.0 mg/l at six inches deep, 14.6 mg/l between one and two ft deep, and 17.8 mg/l between three and four ft. The total salt levels for the same depths were .99, .39, and .66, respectively. However, after a winter cereal crop, a reasonable reduction in nitrate-nitrogen and salinity was found: the nitrate-nitrogen level was 27.0 mg/l at six inches deep, 9.1 mg/l between one and two ft, and 1.2 mg/l between three and four ft. The total salt levels for the same depths were .26, .60, and .28. Similar results were found in soil samples at the vineyard.

The analysis of soil water by extraction through ceramic cups at 18 inches, 5 ft, 10 ft, and 17 ft during the surface effluent application revealed immediate changes in the soil: the pH was higher (8.30 at 18 inches and 7.40 at 17 ft);

and calcium and magnesium levels were higher in surface soils, and occasionally to a considerable depth (182 mg/l at 18 inches and 56 mg/l at 17 ft). Soil water extracts after the winter cereal crops were expectedly lower. The surface pH was 6.8. The soil solution ammonium-nitrogen levels after the canning season were 1.10 mg/l at 18 inches, 1.80 mg/l at 5 ft and 0.60 at 17 ft. The nitrate-nitrogen amounts were 0.17 mg/l, 0.09 and 0.13, respectively, for the same depths. After the winter cereal crop both ammonium and nitrate-nitrogen were reduced about 50% at 18 inches and 5 ft. Little change was noted at 17 ft.

The filtering effect of soils was demonstrated by a two- to five-fold decrease in soil nitrogen and phosphorus from surface to subsoils in the soil sample analysis. Fairly large additions of nitrogen, phosphorus, calcium, magnesium, chlorides and bicarbonates could later cause partial movement to deeper subsoils. Precipitation of salts as lime, and to a lesser extent as gypsum, and crop usage of nitrogen and phosphorus may result in very small ground water eutrophication—after a 10- to 20-year period. Monitoring will continue, in order to observe any changes.

As shown in this experiment, winter cropping seems important to minimize ground water enrichment. Changes in soil solution (soil water) were noted to a depth of 5 ft—the probable result of the depth of flooding and the periodic loading with sugars from cannery operations. But since winter cereal crops root to a considerable depth, soil and soil solution sampling after cropping showed effective extraction of nutrients. A lack of change in deep soil samples and suction probes shown in semiannual soil sampling gives credence to the known precipitation reaction of lime and gypsum in soils.

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