

DEMANDS ARE continually increasing for water from the Colorado River, which is the source of irrigation for the Imperial Valley. This series of experiments was designed to investigate the possibility of greater efficiency in utilization of the water supply through sprinkler irrigation.

The conventional furrow system now in use for row crops requires one or more days to adequately irrigate the 42-inch beds. When lettuce is planted, water is allowed to flow in the furrows for varying periods, as long as 21 days. The continuous flow serves both to cool and moisten the beds and is continued until the desired stand emerges.

The Colorado River water used for irrigation contains approximately 1.3 tons of salt per acre foot. As the water evaporates, a deposit of salt accumulates on the surface of the beds. The salt concentration sometimes falls on the seed rows along the shoulder of the beds, preventing germination of the seeds.

Sprinkler vs. furrow

The first experiment, initiated on October 29, 1964, compared sprinkler and furrow irrigation on precision- and conventionally seeded plots. Seeding rates were 3.0, 0.7 and 0.5 lb of seed per acre. The 0.5-lb rate was placed at 2-inch intervals using a Clow Vac Jet planter; and the other rates were applied with a Planet Jr. seeder. Results showed irrigation by sprinklers caused no observable damage to plants due to salt concentration on the leaves, and no humidity-induced pathogen developed. In addition, the sprinkler-irrigated, precision-planted plots matured at a uniform rate sufficient to allow 71% of the heads to be harvested at one time. The other seed rates and furrow irrigation required three harvest periods at weekly intervals. Furthermore, the 71% yield was from one to two weeks earlier than those of other treatments. The favorable results from sprinkler irrigation were associated with the maintenance of low surface-salt accumulation in the seed rows.

The second experiment, initiated on January 18, 1965, compared carrot growth on conventional 41-inch beds with growth on an 82-inch bed—under both furrow and sprinkler irrigation. This experiment showed that a significantly greater number of plants emerged in the wide beds where salt had been removed from the soil surface by sprinkling—resulting in a significantly higher yield on the 82-inch, sprinkled, beds. This carrot experiment demonstrated the salt-

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removal advantage of sprinkler irrigation in allowing great flexibility in bed size and shape, and leading to more efficient utilization of existing crop acreage.

An auxiliary greenhouse experiment established that the cause of carrot forking observed in the test program was the conventional broadcast-placement of ammonium nitrate pellets prior to bedding up. This left a planar configuration of pellets 1 inch below the germinating seedlings. The probability of a direct hit upon one of these high concentrations of fertilizer by a tender radical was greatly increased by the placement configuration. The forking could be avoided by mixing the pellets in the soil before bedding.

The effect of increased carrot density

upon the growth rate of carrots under sprinkler irrigation is also under investigation, and should lead to recommendations of proper seeding rates.

The third experiment examined the microclimatic-modifying effects of sprinkler irrigation. This experiment was initiated on August 30, 1965 with pelleted sugar beet seed. Seeds were placed at 16 per foot of row by using an International Harvester 185 precision planter. Three irrigation regimes were compared, including (1) a continuous furrow flow of water until the seeds emerged; (2) furrow irrigation for one day per week; and (3) sprinkler application for one day, followed by three hours per day for the first week. The daily applications pre-

Photo below shows carrot beds with spotty stand in foreground resulting from furrow irrigation, in contrast to solid stand of larger plants in background that had been sprinkler irrigated.



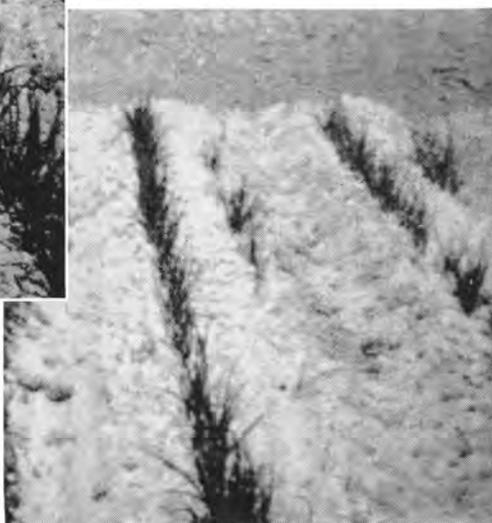
Sprinkler Irrigation Imperial Valley

F. E. ROBINSON
O. D. MCCOY
G. F. WORKER, JR.



Photo above shows solid stands of onions under sprinkler irrigation in experiment four.

Photo below shows one-sided stands of onions as affected by salt accumulation resulting from furrow irrigation in experiment four.



vented entrapment of the emerging seedlings by soil crusting.

Both the furrow and sprinkler irrigations lowered temperatures approximately 20°F with the sprinkler plots being 2°F cooler than the furrow plots, at the half-inch depth. Soil salinity in the seed rows was approximately one-third as high as that in the furrow areas. The emergence of seedlings was 78% in the sprinkler plots, 44% in the intermittent furrow plots, and 32.5% in the continuous furrow plots. Greenhouse experiments disclosed that the inhibiting effect of the continuous furrow irrigation resulted from the exclusion of air by water in the soil. The significantly higher emergence rate of pelleted sugar beet seed under sprinkler irrigation was attributed to lower salinity, cooler temperature, and better soil aeration.

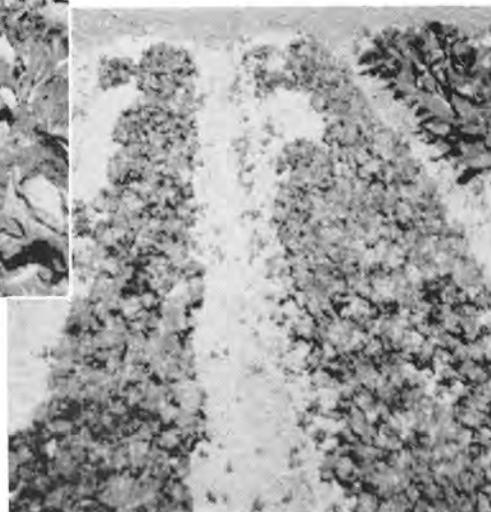
The fourth experiment—conducted with lettuce, cabbage, carrots, and onions—was begun October 14, 1965, and compared sprinkler and furrow irrigation at

Sprinkler irrigation reduced surface salt accumulation, increased water use efficiency, and cooled the soil surface more effectively than conventional furrow irrigation in recent tests. No detrimental effects were observed on lettuce, cabbage, carrots, onions or sugar beet seedlings from sprinkler application of Colorado River water. Emergence of seedlings was significantly higher with cabbage, sugar beets, carrots, and onions—and in some cases with lettuce—when sprinkled, as compared with furrow irrigation. When combined with precision planting, sprinkler irrigation resulted in earlier maturity of lettuce as well as highest yields obtained from a single harvest. Further studies will be needed to re-evaluate cultural practices involved in changing from furrow to sprinkler irrigation.



Photo below shows one-sided stand of lettuce and cabbage resulting from accumulation of salts during furrow irrigation.

Photo above shows solid stands of lettuce and cabbage under sprinklers in experiment four.



three intervals of application. Stands were first established and then the irrigation intervals were imposed, based on the rate of evaporation from a class A US Weather Bureau pan. The wettest interval involved an irrigation for each 1½ inches of water evaporation; the intermediate treatment, for each 2 inches; and the dry treatment, for each 3 inches of evaporation. Results of this experiment showed that the sprinkler irrigation removed soil-surface salt, producing a higher rate of emergence of cabbage, carrots and onion seedlings. The driest treatment significantly reduced onion bolting on early plantings. The intermediate treatment on carrots produced a significantly higher yield of carrots than the dry treatment, and used less water than the wet treatment. Both carrots and onions were shown to have growth rates dependent upon plant population density.

These results indicate that in changing from furrow to sprinkler irrigation, either rates of seeding should be reduced, or a longer time allowed for the crops to mature. Water use under furrow irrigation was 2½ times greater than that required by sprinkler irrigation. Additional experiments are under way to adjust herbicide and insecticide applications in changing from furrows to sprinklers.

A series of experiments with precision planting of lettuce resulted in the achievement of 84% of a perfect stand of lettuce from a 12-inch spacing of raw lettuce seed placed with the UC-Giannini precision planter. During September and October of 1966, growers germinated more than 1,000 acres of lettuce by sprinkler irrigation for the first time in the Imperial Valley. Rainfall caused a soil crust to develop on one field, but where sprinkler irrigation had been used, an acceptable stand was obtained. Where furrows had been used no stand was obtained and replanting was necessary. Results from sprinkling on lettuce were generally favorable and it is anticipated that considerably more acreage will be put under this method of irrigation in coming years.

Frank E. Robinson is Assistant Water Scientist; Orval D. McCoy is Associate Specialist in Vegetable Crops; and George F. Worker, Jr., is Associate Specialist in Agronomy, University of California, Imperial Valley Field Station, El Centro. Assistance with this project was received from Rain for Rent (Riverside), Rainbird Sprinkler Corporation, Perma Rain Irrigation Company, Henning Produce Incorporated, Clow Seed Company, Vessey and Company Incorporated, and Holly Sugar Corporation.

H. YAMADA

B. B. FISCHER

C. R. POMEROY

To obtain maximum yields of barley in the San Joaquin Valley, a normal (12" to 14") pre-irrigation and at least one supplemental crop irrigation are required, according to these studies. When a heavy pre-irrigation is applied, the soil may be wetted below the potential rooting depth of the barley, in which case the moisture would not be available to the plants.

BARLEY IS PLANTED on more irrigated acres in the San Joaquin Valley than any other single crop. Yields fluctuate greatly from season to season, and from area to area—from a low of 1800 lbs per acre to 5800 lbs per acre. This great fluctuation in barley yields can be attributed mostly to moisture availability during critical times of the growing season—although soil-fertility levels, planting dates, and the disease situation can also play key limiting roles.

Pre-irrigation with 12 to 14 inches of water and one additional irrigation in late February or early March (when the barley is in the early boot stage) produced the most economical returns in earlier, non-replicated, trials. A 1964 study demonstrated that pre-irrigation without supplemental irrigations, a common practice of many barley growers in the San Joaquin Valley, resulted in production of yields that were uneconomical and below optimum levels.

In the study reported here, an irrigation experiment was conducted on a Panoche clay loam soil to determine yield responses to varying amounts of water applied by pre-irrigation and crop irrigations on barley. The experiment was conducted on a grower's field (Boston Ranch Company, Westhaven, Fresno County), and included four treatments with three replications. The treatments were as follows: B1, heavy pre-irrigation only; B2, normal pre-irrigation plus two crop irri-

gations (early boot stage and flowering stage); B3, normal pre-irrigation plus one crop irrigation (early boot stage); B4, normal pre-irrigation only. Plots were 25 ft wide and 640 ft long. All plots were uniformly fertilized, prior to the pre-irrigation, with NH₃ gas injected in the soil to a depth of 9 inches with 16-inch spacing, at the rate of 80 lbs of nitrogen per acre. Following pre-irrigation in mid-October, 70 lbs per acre of California Mariout barley were drilled into the plots on December 4. Plots were machine harvested (center 12 ft for the full length of the plot taken for yield measurement) on June 23. Rainfall between planting and harvest was approximately 2.5 inches.

The amount of water applied in pre-irrigation and in each crop irrigation was measured through siphon tubes for each plot. The amounts applied to the treatments were as follows: B1, 22.1 inch pre-irrigation; B2, 12.2 inch pre-irrigation plus 7.6 inch early boot stage and 4.8 inch at flowering stage (total 24.6 inch); B3, 12.6 inch pre-irrigation plus 7.8 inch early boot stage (total 20.4 inch); B4, 14.5 inch pre-irrigation.

Soil samples were taken from each foot to a depth of 8 ft from eight locations in the field, prior to pre-irrigation, to determine the initial moisture content of the field. All treatments were sampled at two locations after pre-irrigation and after harvest. The bulk density, averaging 1.4 gm/cm³ at 8 ft, was determined from two pits dug in the field after harvest, with a back hoe. Using the density figure of 1.4 gm/cm³ and the oven-dried weight of the soil sample, calculations were made of the total inches of water for each treatment at the time of sampling. From the soil samples collected before and after pre-irrigation, it was found that 29% of the 22.1-inch pre-irrigation in B1 percolated below the 8-ft depth of sampling.

Evapotranspiration rates for treatment B1, B2, B3, and B4 (see table) were 47%, 72%, 74% and 72% respectively, of