Irrigation rates critical in Imperial Valley alfalfa

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The replacement of furrow irrigation by sprinklers for germination of crops in California's Imperial Valley has conserved water by eliminating runoff and increasing the degree of control. Sprinkler irrigation saves 60 percent of the water previously used to germinate lettuce by furrow irrigation and also has produced higher emergence rates in alfalfa, barley, cabbage, carrot, flax, lettuce, onions, safflower, sugarbeets, and wheat.

In this desert climate, rainfall averages 72 mm per year, and maximum temperatures exceed 37° C from mid-June to mid-September. The average monthly relative humidity varies from 20 to 40 percent throughout the year. Irrigation water brought from the Colorado River contains approximately 875 mg per liter total dissolved solids, which concentrate where water evaporates. Drainage tile is used to remove salts from the soil profile.

Sprinkler application rates greater than the soil intake rate cause ponding and soil crusting. Studies of six crops in 1969 showed lower seedling weights associated with application rates greater than 5 mm per hour, which ponded clay and sandy clay-loam soils. In an alfalfa trial when Imperial clay was ponded, soil bulk densities increased from 1.47 to 1.61 grams per cubic centimeter (g/cc). In unponded soil the 1.47 g/cc bulk density of the aggregated seed bed was preserved. This was associated with a much higher seedling emergence and 1.2 tonnes per hectare greater yield after the first two harvests.

Sequentially reducing nozzle size at a given pressure causes both the application rate and the average droplet size to decrease. Other researchers have shown that the rate of cooling and evaporation of water droplets in air increases with the inverse square of the droplet diameter. Therefore, as nozzle sizes decrease at a given pressure, the rate of salt concentration in the irrigation water increases. The constraint on the minimum application rate of sprinkler irrigation was, therefore, expected to be the rate at which the evaporative concentration of water salinity was great enough to damage the leaves.

Leaf Burn Associated with Three Water Application Rates in Imperial Valley, California, June 27, 1979

Application rate*	Plants with leaf burn†
mm/hr	%
1.79	92.5
2.73	5.0
4.03	2.5
LSD 0.05	7.9

*Water contained 875 mg/liter total dissolved solids. Nozzle sizes were 1.58 mm at 1.79 mm/hr, 1.98 at 2.73, and 2.38 at 4.03.
†Plants with two or more leaves completely dry in the top 10 cm.

The objective of the work reported here was to define the critical minimum application rate below which the concentration of salt in the irrigation water would cause leaf burn during the high evaporative summer demand period.

Procedure

The study was conducted in a 21-month-old stand of *Medicago sativa* L. alfalfa (CUF 101) irrigated with a permanent solid-set irrigation system. The field had Imperial clay on the west side and a Meloland sandy clay-loam on the east side. The soil is classed as torrifluvient of the mixed calcarious hyperthermic family. The profile was tile drained at a 1.8-meter depth to control the water table.

The alfalfa was cut and harvested on May 2, 1979. Three irrigations followed on May 15, May 30, and June 14, 1979. The total application was 44.5 cm, which was determined at 0.75 x evaporation from a Class A USWB pan. The treatments consisted of three different application rates from three different nozzle sizes: (1) 1.79 mm per hour from a 1.58-mm nozzle; (2) 2.73 mm per hour from a 1.98-mm nozzle; and (3) 4.03 mm per hour from a 2.38-mm nozzle. The pressure used was 414 kPa (60 psi), and the sprinkler spacing was 9.15 by 12.2 meters. There were four replications of a randomized block design.

To quantify the degree of leaf burning, 10 plants were selected on a 4-meter transect in the alfalfa plots. The number of plants with two or more leaves completely dry in the top 10 cm was recorded on June 28, 1979.

Results and discussion

A definite break in percentages was evident between the 1.79 and 2.73-mm-per-hour application rate. The lowest rate (1.79 mm per hour) was associated with 92.5 percent leaf burn in the top 10 cm. The higher rates were associated with only 5 percent or less leaf burn. This study was conducted during a period of high evaporative demand.

Temperatures during the times of application ranged from a maximum of 30.6° to 42.8° C, and a minimum of 12.8° to 27.2° C. Relative humidities at maximum dry bulb ranged from 26 to 36 percent and 57 to 65 percent at low dry bulb. Average (12-hour) wind velocity ranged from 2 to 21.7 km per hour.

These data indicate that to avoid alfalfa leaf burn, application rates should not be below 2.7 mm per hour, and nozzle sizes should be at or above 1.98 mm (5/64 inch) during the high evaporation demand period in this arid area.

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