Effect of irrigation frequencies on alfalfa seed yield

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Alfalfa, at full bloom, in the furrow irrigation study.
Alfalfa, before flowering, in the subsurface drip irrigation study.

Maximum alfalfa seed set in the Imperial Valley is achieved through slight water stress, which is sufficiently high to suppress vegetative growth but not so high as to reduce pollination and seed development. Alfalfa seed yields were maximized in a previous experiment by maintaining an average of 50-centibar soil water tension at 9 inches below surface drip irrigation lines (*California Agriculture*, November 1975). Average soil water tensions of 10, 100, and 200 centibars produced lower yields. Daily water applications and 12-inch orifice spacings were used.

When plastic drip irrigation lines were placed underground to reduce sunlight and mechanical damage, yields decreased with greater orifice intervals, from continuously porous to 36-inch intervals (*California Agriculture*, April 1976). In our present study, we compare water application frequencies for subsurface drip and furrow irrigation systems in the Imperial Valley.

Several conditions and procedures were common to both experiments although each experiment was conducted separately. A Holtville silty clay soil was used, the upper 2- to 3-foot layer of which has a fine texture and a relatively high water-holding capacity. All treatments within each experiment were irrigated the same, as for hay production, except during the seed-production period. Phosphorus was applied at the beginning of each seed-setting period at 50 pounds P per acre, in the acid form, through drip lines or sidedressed, as super phosphate, in the furrow study. Honeybees were provided, at a minimum quantity of eight colonies per acre, for pollination during the seed-setting period. Insecticides were applied as needed

for controlling aphid, lygus, stinkbug, and cricket.

Drip irrigation

Continuously porous drip tubing was installed in 12 plots. Each plot was 20 feet long and contained six parallel lines placed 6 inches deep on 40-inch centers. Drip lines were connected through a control panel of flow valves and time clocks to provide three irrigation treatments randomly arranged within four replicates. The experimental area was flat. Moapa 69 seed was planted in rows 6 inches to each side of the drip tubing and 1/3 inch deep. Sprinklers were used on October 23, 1974, and on several occasions until February 1, 1975, for seed germination and to establish a uniform seedling stand. The drip irrigation system was started on December 2, 1974, to supply water daily, or several times a week, in amounts necessary to maintain a soil water tension of 10 to 30 centibars 9 inches deep in the plant row. Seedlings were thinned to a 6-inch spacing. Because of leaks after one year of service, the original tubing was replaced with bi-wall tubing with 12-inch orifice spacing. The new tubing was placed 2 inches below the soil surface and the old tubing was left in place. The tensiometer location was changed to 7 inches below the new drip lines. The alfalfa was cut on May 15, 1975, and April 23, 1976, to start the seed production periods.

Irrigation frequencies of once daily, twice weekly, and once weekly were started at the early bloom stage on June 2, 1975 (for the 1975 seed), and May 13, 1976 (for the 1976 seed). All treatments received the same total amount of water per week. The amount of water per application for the twice- and once-weekly frequencies was determined by the amount required to maintain a 50- ± 20-centibar soil water tension at the reference location in the once-daily frequency. The daily water requirement was usually between 7100 and 8700 gallons per acre per day (0.26 to 0.32 inches per day) during June, July, and August. During April and May, when plants were treated uniformly for hay production, water applications usually varied between 4000 and 6500 gallons per acre per day (0.15 to 0.24 inches per day). The plots used for the once-daily and once-weekly frequencies were exchanged in the spring of 1976. Clean seed yields obtained during the two years of the experiment are shown in table 1.

TABLE 1. Subsurface Drip Irrigated Clean Seed Yields Harvested on August 22, 1975 and September 1, 1976

Treatment	1975	1976
	pounds/acre	
Once daily	461*	355
Twice daily	612	402
Once weekly	540	308

*Yields are not significantly different at P = 0.05, in either year.

Furrow irrigation

In October 1975, seed of UC Salton alfalfa was planted at 2 pounds per acre on double row beds spaced 40 inches between centers. Seed rows were 12 inches apart on the beds. Seedlings were not thinned. Thirty plots were arranged for randomizing five treatments within six replications. Individual plots were six rows wide and 60 feet long. Plots were separated by a bare area of two beds within replicates and 30 feet between replicates to assist bees in identifying their preferred plots. Tensiometers were placed at 12- and 18-inch depths midway between the plant rows in the center of one of the two center beds in the treatments; gypsum blocks were placed at a 12-inch depth adjacent to the tensiometers. The alfalfa was cut on May 14, 1976, to start seed production. The last common irrigation was applied to all plots on June 4.

Five irrigation treatments included irrigation of: (1) every furrow every 7 days, (2) alternate furrows every 7 days with the dry furrows alternated between successive irrigations, (3) every furrow every 9 or 10 days, (4) alternate furrows every 9 or 10 days with the dry furrows alternated between successive irrigations, and (5) the same alternate furrows every 9 or 10 days. With a 24-hour irrigation, the soil wetted about three-quarters of the distance across the beds with alternate furrows irrigated and beds wetted entirely with every furrow irrigated. Soil water tension at both depths usually exceeded the tensiometer range for 1 to 2 days before irrigation of treatments (1) and (2) and several days before irrigation of treatments (3), (4), and (5). The gypsum blocks did not perform satisfactorily within their laboratory-determined calibration curves. Clean seed yields are shown in table 2.

Discussion

Clean seed yields were highest with furrow irrigation at 7-day intervals and were lower with furrow irrigation at 9- or 10-day intervals and with subsurface irrigation at all frequencies. Every-furrow and alternate-furrow applications yielded equally when the dry furrows were alternated between successive irrigations. With alternate furrow irrigation always in the same furrows, plants in rows adjacent to the dry furrow received insufficient water and produced low seed yields. Irrigation frequencies of once daily, twice weekly, and once weekly produced equally low alfalfa seed yields with the subsurface drip system.

Drying winds prevented seed production during periods in both experiments. In the furrow experiment, plants were in full bloom between June 14 and 28, 1976, but very little seed was set. Afternoon winds, estimated at 5 to 10 miles per hour, caused flowers to dry and be shed, although morning counts indicated excellent bee visitations. A heavy seed set occurred during the succeeding two-week period when winds did not occur and bee visitations were fewer. During the windy period, seed set was negligible in the subsurface drip experiment, where plants had already set much of their final seed yields. Strong winds also prevented seed set in the subsurface drip experiment during early June 1975. Because winds may occur at any time in the Imperial Valley, a farmer cannot effectively plan or select a wind-free period for seed setting.

Data from these and the previously cited experiments indicate that planting alfalfa on beds may be important for maximum seed yield on clay soils in the Imperial Valley. Yields were higher with drip and furrow irrigation on beds than on the flat. Low seed yields in fields previously used in hay production support this conclusion.

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TABLE 2. Furrow Irrigated Clean Seed Yields Harvested on September 1, 1976

Treatments	Days between irrigation	Yields
		pounds/acre
Every furrow	7	953a*
Alternating furrows	7	952a
Every furrow	10	596b
Alternating furrows	10	615b
Every other furrow	10	445c

*Yields significantly different at P = 0.05 if not followed by the same letter.