# IRRIGATION EFFECTS ON ALFALFA YIELD, QUALITY, AND SOIL CHARACTERISTICS

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Production of high yielding, high quality alfalfa in the low-elevation desert valleys of the Southwest has long been a challenge to which many growers have successfully responded. High quality alfalfa forage is readily accepted in nearby markets, thereby furnishing a dependable outlet for the product and helping to provide stability to the agricultural economy of the area.

Because alfalfa is a year-round crop and because the nature of the crop is primarily vegetative, it has a high water requirement. This is especially true in the warm low-elevation deserts where high water evaporation rates are common in summer months. However, due to the favorable growing conditions over much of the year, high annual yields are possible.

## Irrigation and Yield

At the Imperial Valley Conservation Research Center we have been conducting irrigation trials wherein varying amounts of water were applied to alfalfa plots for several years. The treatment included irrigations based on 56, 66, 75 and 84% of pan evaporation from a class A weather pan. The 75% treatment represented our best estimate of annual Et (evapotranspiration or plant use). Since unbuffered pan evaporation rates exceed 100 inches per year in the low elevation deserts, the application rates amounted to approximately 60, 70, 80 and 90 inches per year.

Additionally, we had modified irrigation treatments in which annual amounts of 70 and 80 inches were applied but with proportionately more water applied in winter and spring and less water applied in summer. The 1976 yield results are given in Table 1.

Table Irrigation Treatments and Yields - 1976.

| Treatment | Water Applied | Yield | | |
|---|---|---|---|---|
| | | 1st 6 mo. | 2nd 6 mo. | Total |
| | in./year | tons/acre | | |
| Dry | 60 | 3.80c | 3.76c | 7.56d |
| Semi-Dry | 70 | 4.76b | 4.50b | 9.26c |
| Moderate | 80 | 5.74a | 5.21a | 10.99ab |
| Wet | 90 | 5.92a | 5.26a | 11.18a |
| Semi-Dry | 70* | 5.62a | 4.02b | 9.64c |
| Moderate | 80* | 5.66a | 4.76b | 10.42b |

* Winter and spring leaching, summer depletion.

Numbers in a column not followed by the same letter are different from each other at the 1% level.

At the dry end of the irrigation range, yields decreased to 68% of the check when 75% less water than estimated Et was applied to the crop and 84-88% when 88% of estimated Et was applied. At the wet end of the irrigation range, yield increased to 102% of the check when 112% of estimated Et was applied.

## Water Use Efficiency

The efficiency with which the alfalfa plant is able to utilize available water will vary during the year. Water use efficiency, here defined as the units of water applied per unit of forage produced, is generally greater in periods of good growth and moderate evaporation. By way of illustration, if we take the 1976 yields of the alfalfa in experimental plots at the IVCRC (Table 1), and divide the yield into two 6-month periods, it can be seen that slightly over half of the forage is produced in the first 6 months. The two modified irrigation treatments showed a larger decline during the second 6-month period principally because less water was applied to these plots during summer and early fall.

When a water use efficiency evaluation is applied to these same treatments, the more inefficient time period becomes apparent (Table 2). Both the dry and wet treatments are generally less efficient than the moderate (the treatment used as an estimate of evapotranspiration) treatment.

Table 2 Alfalfa Water Use Efficiency - 1976.

| Treatment | Water | W U E | | |
|---|---|---|---|---|
| | | 1st 6 mo. | 2nd 6 mo. | Total |
| | in./year | units water/units forage | | |
| Dry | 60 | 758a | 1060ab | 906b |
| Semi-Dry | 70 | 699a | 1022a | 856ab |
| Moderate | 80 | 658a | 1009a | 824a |
| Wet | 90 | 720a | 124b | 908b |
| Semi-Dry | 70* | 702a | 995a | 824a |
| Moderate | 80* | 723a | 1038a | 867ab |

* Winter and spring leaching, summer depletion.

Numbers in a column not followed by the same letter are different from each other at the 5% level.

## Quality

In addition to yield and water efficiency studies, quality appraisals of forage produced from different irrigation treatments are currently being made at IVCRC. Preliminary results show that at certain times of the year drier treatments produced higher quality forage. This may be due to coarseness or fineness of stems in the different treatments.

Another factor that ultimately influences crop quality is stand density. If a stand becomes too thin, it is subject to weed and grass infestations. Stand counts taken in the IVCRC irrigation plots 18 months after differential treatments are given in Table 3.

Table 3 Plant Stand Counts - January 1977.

| Treatment | Plants/square foot |
|---|---|
| Dry | 23 |
| Semi-Dry | 22 |
| Moderate | 22 |
| Wet | 19 |
| Semi-Dry W L | 22 |
| Moderate W L | 18 |

The stand in the wet treatment showed additional decline in succeeding months. The moderate winter-leaching stands also tended to become thinner. A winter stand decline in intensively watered plots is probably more related to disease organisms than to low oxygen in the soil during flooding times. In recent aeration experiments at IVCRC, soil oxygen was not as low in the winter as in the summer under the same flooding regimes.

## Soil Salinity and Water Content

In the IVCRC experiments, soil salinity was found to increase appreciably in the top two feet in the drier treatments. On the other hand, salinity of the wetter treatments increased most at the 2-4 foot depths. It should be noted that when the salinity of the 5-foot soil profile of all treatments was compared, the total salt profile of the wetter treatments was at least equal to or exceeded the drier treatments. Yield, however, was more related to the salinity of the top foot of soil than either the top 2 feet or the top 3 feet of soil.

Chloride ion analysis was used to pinpoint peak salt concentrations at various root-zone depths. The chloride determinations also furnished a guide to water movement in the soil. Only the wetter irrigation treatments had substantially increased water contents below 2 feet. Yield was well correlated with water content in the 0-3 foot soil profile.

## Other Considerations

There are certain prerequisites to effective alfalfa water management. A thorough knowledge of the soil characteristics of the fields which are scheduled for alfalfa production is needed. One basic item to know is the preplanting water status of the soil to a depth below the expected root zone. The infiltration rates, and soil texture and stratification should also be known.

When irrigation applications amounts approximately equal to evapotranspiration are applied to soils with good internal drainage, harmful soil water levels are unlikely. However, soils with restricted internal drainage may have to be monitored to guard against excessive water buildup. Recent IVCRC field surveys have shown that a substantial number of 2nd and 3rd year alfalfa fields tend to have a high subsoil water content. Soil coring or the neutron probe can be used to monitor deep soil moisture. Tensiometers may also be useful in determining soil water status in and below the alfalfa rootzone.

In summary, precise water management is certainly a basic component of efficient low desert alfalfa production. Careful management of other production factors is also necessary to achieve good alfalfa yields and high water use efficiency.