OPTIONS IN ALFALFA IRRIGATION SCHEDULING

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Water management is an important factor controlling alfalfa yields. Today, I will discuss alfalfa irrigation scheduling options in the desert southwest. This will include both the interval and amount of water applied.

We became interested in this problem about four years ago because it appeared that farmers in the Imperial Valley were under-irrigating alfalfa. Water records were checked and many farmers were putting on less water than consumptive use and often obtaining reduced yields because of this.

The reasons for the under-irrigation of alfalfa included fear by the farmer that extra water would reduce stands as a result of scald. Therefore, they were sacrificing yield to protect their stand.

In heavy soils, when alfalfa is flood irrigated, the soil surface is sealed and there is virtually no flow of oxygen to the root zone. Oxygen consumption by roots and microbial populations lower the residual oxygen content of the soil. After a few days the soil has usually dried sufficiently so that oxygen can flow into the soil again. In desert areas the oxygen problem is more severe because oxygen consumption is higher than elsewhere due to higher temperatures.

An example of this condition was seen after the tropical storm Doreen, which occurred in August of 1977. Fields that had been irrigated several days before the rain were still under low oxygen. When more water came by rainfall, the low oxygen continued, killing the alfalfa.

In addition to problems relating to low oxygen conditions, we have additional constraints in alfalfa irrigation scheduling due to the basically low water infiltration rates of our soil. Harvest scheduling must also be considered. Finally, there is often difficulty in meeting peak water use demands.

We began a major study of alfalfa water use under desert conditions in 1974. The objectives of the study were:

To see if stand could be maintained when alfalfa was irrigated at Et. (evapotranspiration or consumptive use).

2. To evaluate the effects of irrigating alfalfa at less than, and in excess of, Et.

3. To evaluate yield at each of these treatments

Two varietal types of alfalfa were included in the study to get an idea of genetic response to a wide range of irrigation treatments.

The basic treatments were dry (75% of estimated Et), semi-dry (88% of Et), moderate (our best estimate of water use or Et for this study 75% of Class A weather pan evaporation), and wet (112% of Et). Two other treatments were included. These could be classed as semi-dry and moderate on an annual basis, but we added more water than Et in winter and spring and less water in summer and fall.

Yield

The dry treatments resulted in significant yield decreases. The semi-dry treatments also gave significant yield reductions but these reductions were not always significant at each cutting. Yields are given in Table 1.

Table 1. Annual alfalfa yield in six irrigation treatments.

No.	Treatment	% of estimated use	% of pan evap.	Yield (tons/acre) Mesa Sirsa	Yield (tons/acre) Salton
1	Dry	75	56	7.33 d	7.79 c
2	Semi-dry	88	66	9.06 c	9.45 b
3	Moderate	100	75	10.80 a	11.18 a
4	Wet	112	84	11.07 a	11.29 a
5	Semi-dry	88*	66	9.60 bc	9.68 b
6	Moderate	100*	75	10.46 ab	10.38 ab

* Winter and spring leaching, summer and fall depletion.

For each variety, numbers in a column not followed by the same letter are different from each other.

The wet treatment, 112% of Et, yielded as much forage as the moderate treatment but in the last year of testing showed considerable stand loss.

Plots with extra water applied in winter and spring and deficit amounts applied in summer and fall, had yield reductions in the semi-dry treatments but no reductions when irrigated with the same annual amount as Et.

The alfalfa variety Salton performed slightly better than the variety Mesa Sirsa in both dry and wet treatments, but also lost plants in the wet treatment. Mesa Sirsa tended to thin more in summer than Salton. Some specific thinning of Salton was noted in the winter months in plots receiving winter and spring leaching.

Salinity

Salinity decreased in the top foot of soil in the moderate and wet treatments but increased somewhat in the rest of the 5-foot profile that we sampled. Maximum salt accumulation was at 3 to 4 feet in these treatments. The maximum zone of salt accumulation was located in the top 2 feet in the dry and semi-dry treatments. Salinities increased from original values of 6-8 mmho to final values of 10-12 mmho in the highest salt zones. Soil salinity was sufficiently high to contribute to the reduced yield of the dry and semi-dry treatments.

Soil Air

In the layered soils used in the experiments, soil oxygen was not often sufficiently low enough to cause yield decreases if an adequate stand remained. Those plots with low soil oxygen (wet treatments) eventually lost plants. On a commercial basis, weed or grass infestations would invade the thin spots and contribute to yield and quality losses. Critical soil oxygen levels were about 5%.

Tailoring Irrigation Scheduling to Local Conditions

Alfalfa yields have been shown to be highest when irrigated on a schedule which closely follows evaporative demand. Many area growers apply amounts equivalent to 75% of evaporative demand and the reported yields are in a range similar to yields from the dry or semi-dry irrigation treatments (approx. 8 tons).

In cases where growers have difficulty meeting evaporative demands, especially in peak use periods, the experimental data suggests that a satisfactory alternative is to apply some extra water (above Et) in winter and spring. Since most soils in our area do not support root systems below 2-3 feet, the actual amount of water involved may not exceed 5 inches. This water could be added to the profile in the first 6 months of the year and "subtracted" from the applications during the last half of the year.

Soil moisture monitoring is essential when irrigation frequencies and amounts vary from actual evaporative demands. A number of excellent devices are now on the market. These include the neutron probe, tensiometers, improved soil moisture blocks, and hydraulically operated coring tubes. We found that we could readily monitor wet or dry zones in the major root zone under winter leaching - summer depletion treatments. Similarly, we observed that the average root zone soil water content of our moderately wet treatments rarely exceeded 40% or fell below 25% (volume).

Pressure bombs, leaf sampling discs and similar instruments have been used to get an idea of plant water status. Another diagnostic tool which may become more prominent in detecting pre-visual plant stress is the infrared thermometer.

Frequency of water application and amounts may both have to be altered to achieve the desired soil moisture range. For example, under low infiltration conditions, 3 inches of irrigation water may infiltrate fairly rapidly while 4 inches may not be taken in for much longer periods. Increasing the frequency would be necessary. Four irrigations of 3 inches each, rather than three irrigations of 4 inches each, would be needed to apply 12 inches of irrigation water.

As we mentioned in the introduction, harvesting does impose constraints on times when irrigations may be scheduled. Desert alfalfa is usually cut 7-9 times per year. Even within the growing period, the option of frequency may revolve around whether to apply two or three irrigations per cutting. Here it may be helpful in summer to apply lighter irrigations when the alfalfa is short and the ground is virtually unshaded and more thorough irrigations as the forage grows taller. In winter, the irrigations could be more uniform.

It is important that local considerations be taken into account. By way of illustration, the onset of warm weather in spring will vary with location and season. Soils which shrink and swell or have high clay contents will undoubtedly be handled differently than open porous soils. Using adapted alfalfa varieties fitted to local conditions is essential. A specific growth habit or tolerance to drought or wet conditions may give a grower the edge in obtaining satisfactory yields under less than favorable conditions.

Even though there are many constraints on flexibility in alfalfa irrigation scheduling, it is still urgent that growers and water supplying agencies be continuously aware of the consumptive use values for their particular area. The replacement water can then be apportioned accordingly. As a general rule of thumb, the various methods of assessing consumptive use for a current crop should not vary greatly from established values. The current climatic trends need to be followed closely, however. If one method is chosen as the primary criteria, the other methods can be used as cross-checks.

Water savings can be made throughout the growing season by careful integration of grower goals, major constraints, and the use of a proven irrigation scheduling system.

Summary

1. Alfalfa yields were highest when irrigated at or near consumptive use 1 tons as compared to 7.5 tons where 25% less water than Et was applied).

2. On low infiltration soils, it may not always be possible to irrigate at or near Et, especially in peak use periods.

3. If it is impossible to keep up with Et on a continuous basis, other specific means (as in our case, the winter-spring additions) may be used to approach top yields.

4. When an irrigation program varies from reliable Et values for a given area, a comprehensive soil-climate monitoring system is needed.

5. Even when options with frequency and irrigation amounts are limited, a careful addition or deletion of water can be made at each irrigation.

6. The effectiveness of options will depend on how accurately the grower assesses the dominant limiting or enhancing factors in his own area.