ALFALFA IRRIGATION

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Alfalfa Irrigation Facts

1. Alfalfa reference evapotranspiration (ET) averaged over 18 years at Kimberly by Jim Wright varies from 0.1 to 0.2 inches/day from April 1 to May 1, 0.2 to 0.3 inches/day from May 1 to Sept. 30, and from 0.1 to 0.2 inches/day from Oct. 1 to November 1. Extremes in ET may be about 0.4 inches/day in mid summer.
2. Evapotranspiration (ET) is the primary use of water by alfalfa.
    a. ET = about 36 inches/year
    b. 4076 tons water per acre
    c. 45 tons ET per acre per day average
    d. Irrigated alfalfa yield at elevations < 4000 feet is about 7.5 tons/acre
    e. Hay harvested at 12% moisture removes 240 lbs water/ton hay
3. Yield response is linear, it takes 5 inches of water to produce each ton at Kimberly.
4. Plant stress can occur when available soil moisture decreases below 50%.
5. In some heavier soils, moisture accumulation from the previous fall irrigation and normal or better winter and spring precipitation may be sufficient to produce normal yield for first cutting (assuming rooting depth is adequate). Sandy soils have much less water-holding capacity. In northern California Hansen (1989) found little response of alfalfa hay yield to applied water for the first cutting because of stored moisture in soil from normal winter and spring precipitation.
6. In a 4-cut system, the first cutting usually makes up about 35-38% of the year's total forage yield (Fransen et al. 2001), and in a 5-cut system the first cutting contributes about 27% to the total year yield.
7. Water stress results in reduced ET and usually reduced yield (dry matter) because of reduced carbon dioxide conductance into the leaves. This opportunity can never be "made up" by irrigating more than necessary following the stress!
8. Extra water does not produce extra yield!
9. Under moderate moisture stress, alfalfa plants have the ability to go into a drought-induced dormancy. If the plant has adequate carbohydrate reserves, the plant should survive until moisture is returned.
10. In several studies, the cultivar or variety used had no effect on yield for a given amount of water (Grimes et al., 1992; Donavan and Meek, 1983; Hatterdorf et al., 1990; Undersander, 1987). In contrast, yield differences were found in the Imperial Valley (Robinson et al., 1994), however, water use data were not available.
11. Water use efficiency is highest when the water supplied to plants by irrigation, precipitation, or ground water approximates evapotranspiration.
12. Application rates vary substantially:
    a. Surface irrigation can add several inches per irrigation (about 3 inches on average), depending on furrow flow, row spacing, and set time
    b. Set-move systems commonly apply about 1.5 to 3 inches net per irrigation
    c. Center pivots and linear moves apply about 0.5 to 1 inch, depending on water infiltration into the soil, water holding capacity, depth, and speed of revolution/move

Alfalfa Irrigation Recommendations

1. Irrigate early to fill the root zone. Pivots should be slowed down to the point of a little runoff to maximize the depth per irrigation. This is important to have healthy roots in deep soil to take advantage of the soils water holding capacity. A deep soil capacity can be used for alfalfa growth when irrigation is halted for harvest or when application rate does not keep up with ET.
2. Yield response is linear. It takes 5 inches of water to produce each ton at Kimberly.
3. With limited irrigation water, provide adequate water until the water is gone, allow the last cut to be mature and dry when cut so that the plants will go into dormancy.
4. Use the estimated water consumption provided by the AGRIMET data for irrigation scheduling where possible. http://mac1.pn.usbr.gov/agrimet/id_data.html

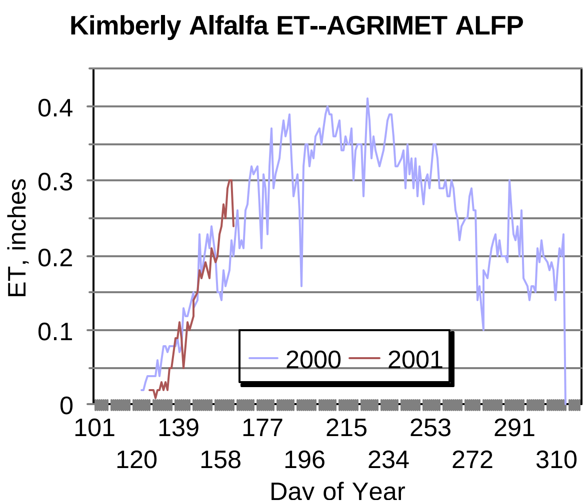

Figure 1. Kimberly Penman ET data from the Twin Falls (Kimberly) AgriMet station.

Strategies for Applying Less Water

1. Prevent over-irrigation through better management of irrigation water.
   a. Irrigation scheduling helps determine when to irrigate and how much to apply.
   b. The water balance approach consists of estimating crop evapotranspiration and applying irrigation when accumulated ET is equal to the allowable soil moisture depletion. Amount applied is determined by ET corrected by the irrigation inefficiency.
   c. The cutting schedule is the major constraint in irrigation scheduling. The soil surface should be dried several days prior to cutting, and then it may be a week before bales are removed. This leaves about a 2-week interval for irrigation between cuttings.
2. Improve the uniformity of distribution and the efficiency of irrigation systems.
   a. No irrigation system can apply water at 100% uniformity. Too much water in one place will cause run off or drainage below the root zone.
3. Perform deficit irrigation.
   a. The power buy-back program may require this strategy.
   b. Delaying irrigation until a canopy is formed will reduce the evaporation component from the soil which may be more efficient (Romanko, 20001).
   c. The first cutting has relatively low ET rates coupled with fast growth rates. Mid-summer cuttings occur at maximum growth rates but also with near maximum ET rates. Autumn growth rates are moderate and ET rates are moderate.

d. Economics of deficit irrigation using yield and cost data from a southern California study (Putnam et al., 2000) found that at low water prices ($50/acre-foot), full irrigation was the most profitable for crop prices greater than about $95/ton.

Definitions and Glossary

evapo-	evaporated water from the soil surface
transpiration	water taken up by the roots and evaporated from plant surfaces (primarily leaves)
ET	evapotranspiration, the combined evaporated water from soil and plant surfaces
alfalfa reference ET	ET from lush, well-irrigated alfalfa at least 1-foot tall
water use efficiency (WUE)	dry matter produced divided by the amount of water consumed

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