ALFALFA IRRIGATION AND DROUGHT

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Water use is high in alfalfa because it has a long growing season, a deep root system, and a dense canopy of vegetation. The amount of water needed for alfalfa production is a function of temperature, wind, humidity, and the amount and intensity of light. The irrigation requirement for alfalfa is determined by rainfall and the water holding capacity of the soils growing the crop. Commonly cited ranges in water requirements for alfalfa are 20 to 46 inches of water per season, depending on climate, elevation, growing season, number of cuttings, latitude, and fall dormancy rating of the alfalfa variety.

Not much water is exported with alfalfa hay. Potential irrigated alfalfa hay yield at elevations near 4000 feet is about 7.5 tons/acre. Hay harvested at 12% moisture removes 240 lbs water/ton hay, or 1,800 lbs/acre for a normal crop of alfalfa hay per year.

Evapotranspiration (ET) is the primary use of water by alfalfa and averages about 36 inches/year (900 mm) at Kimberly. The ET at peak periods of 0.4 inches/day (10 mm/day) can reach 4080 tons of water per acre and 45 tons per acre per day. As shown in Figure 1, adequate center pivot irrigation system capacity is critical for maintaining acceptable soil moisture levels (and yield potential) later in the season. Systems designed and operated to apply less than 7 gallons per minute are not able to match ET and must rely on soil water bank to supply the deficit.

Figure 1. Cumulative estimated ET averaged over 30 years, including cutting effects and irrigation water applied by center pivot at 4 irrigation system capacities for Kimberly, ID conditions.

result from the harvest periods when it takes a few days for the alfalfa to form new leaves and ET to resume significantly.

Yield response to water applied is linear for alfalfa. Research with non-stressed alfalfa at Kimberly (Wright 1988) suggested a requirement of about 5 inches of water to produce each ton of alfalfa. Figure 2 shows similar effects of ET on yield from several sources. Averaged across sites and cuttings at Oakes, ND (Bauder et al. 1978), Israel (Kipnis et al. 1989), and Las Cruses, NM (Sammis 1981) research suggests 6.6 inches of ET to produce 1 ton of alfalfa hay at 12% moisture (M.E. Jensen, personal communication). Lindenmayer et al. (2011) reviewed 9 studies done in the west and Midwest and concluded that it takes 7.4 inches of ET to produce 1 ton of alfalfa. Some of these studies used older varieties of alfalfa and had less frequent cutting schedules than present. Newer varieties may have different root architecture and growth potential.

Figure 2. Season-long alfalfa hay yield at 12% moisture as a function of ET from irrigation studies reviewed by Lindenmayer et al. (2011) and Jensen (2001, personal communication).

In some heavier soils, moisture accumulation from previous fall irrigation and normal or better winter and spring precipitation may be sufficient to produce a normal yield for the first cutting, assuming rooting depth is adequate. Sandy soils generally have too little water-holding capacity to produce a full first cutting under Idaho rainfall patterns. In northern California, Hansen (1989) found little response

Table 1. Maximum irrigation water that can be stored in the active root zone assuming half the available water can be used without water stress (maximum allowable depletion or MAD= 0.5).

Sandy loam (1.7 in/ft * 0.5 = 0.85 in/ft that can be used and refilled)

1 ft	0.8 in
2 ft	1.7 in
3 ft	

season-long deficit irrigation. Management practices that can influence yield/ET ratios under deficit irrigation include stand age, growth stage at harvest, previous water management, and alfalfa variety.

High ET and Drought in 2013

The weather has been hot and dry during the summer of 2013. Alfalfa peak ET has been above the 23-year average at Kimberly (Figure 3). Alfalfa peak ET exceeded 0.35 inches/day for 22 days by August 14, and on 5 days exceeded 0.4 inches/day (Figure 2). Few pivot sprinkler designs can keep up with ET rates above 0.25 inches/day.

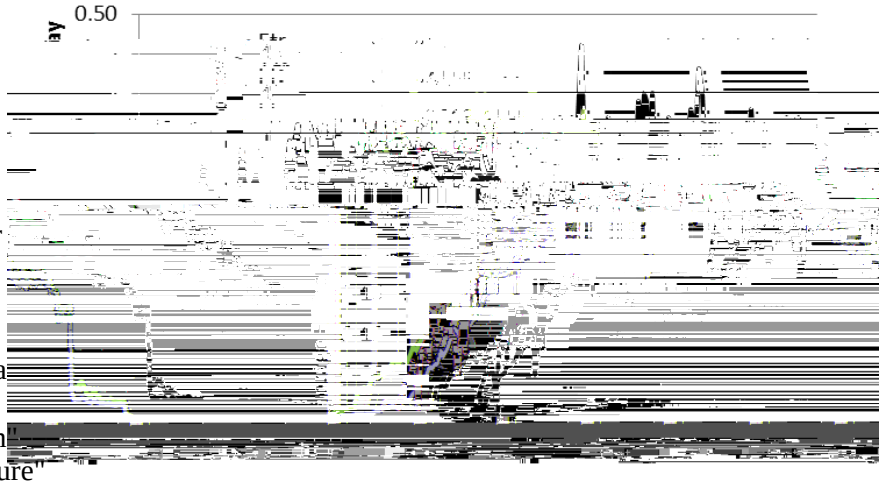

Figure 3. Kimberly Penman ET data from the Twin Falls (Kimberly) AgriMet station. ETr = reference evapotranspiration averaged for 1990 through 2012; (Kimberly-Penman alfalfa reference) from lush, well-irrigated alfalfa at least 1-foot tall. ALFP = alfalfa peak ET averaged for 1990 through 2012, or the "maximum" daily consumptive use for "mature" (uncut) stages of alfalfa growth. 2013 ALFP = alfalfa peak ET for 2013.

Alfalfa Irrigation Recommendations

1. Irrigate early, if the root zone can hold it, during April and May, so that the root zone is nearly full by the end of that period. Pivots should be slowed to the point where the application depth causes a little runoff at the outer span. This will maximize the depth per irrigation, reduce the number of irrigations and therefore, reduce the amount of wasted evaporation from wet leaves

non-structural carbohydrates may allow the plant to starve from lack of energy as plant respiration uses the sugars, or the plant could die from lack of cold-hardiness.

Should growers irrigate in the fall after the alfalfa has been dry and dormant during late summer? How much and when? These are questions that will require more research for us to be able to answer. With high hay prices and uncertainty of weather predictions, it may be the most economical to use the water while it is available and plan to rotate crops sooner than normal if the stand declines.

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 (ETr) reference evapotranspiration (Kimberly-Penman alfalfa reference); 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
ETr - reference evapotranspiration (Kimberly-Penman alfalfa reference)
ALFM - ALFALFA (MEAN)*
ALFN - ALFALFA (NEW PLANT)
ALFP - ALFALFA (PEAK)*
"Peak" chart values represent the "maximum" daily consumptive use for "mature" (uncut) stages of alfalfa and grass hay growth. "Mean" values represent "average" daily use that takes seasonal cuttings into consideration.

References Cited

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