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Deficit Irrigation Strategies to Maximize Alfalfa Returns

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Large-scale field trials were established in the Klamath Basin and the Sacramento Valley in 2003 and 2004. An additional trial was established in Scott Valley in 2004. Information presented here will pertain only to the Intermountain studies and will not discuss the Sacramento Valley studies. The Klamath trial was conducted on two locations with vastly different soil types (a fine sandy loam and a silt loam with high organic matter content). All intermountain sites were sprinkler irrigated with wheel-lines. Irrigation treatments were imposed by plugging three consecutive nozzles on the wheel-line irrigation system for two 12-hour sets so each irrigation treatment was applied to a plot approximately 60 by 120 feet. The irrigation treatments were full irrigation, irrigation cut-off around June 1st after first cutting, and irrigation cut-off around July 15th after second cutting. Yield was measured at second cutting and for each subsequent cutting. Soil moisture was assessed bi-weekly using a neutron probe. Yield was measured for each cutting after the irrigation treatments were imposed. Forage quality (ADF, NDF, and CP) was measured for all treatments at each cutting.

In addition to these on-farm trials, small-plot experiments were established at the Intermountain Research and Extension Center and with a grower cooperator in Malin, Oregon in 2002. Due to lack of initial funding, difficulty applying precise amounts of water with the initial irrigation system, and the desire to implement deficit irrigation treatments on well-established stands, implementation of irrigation treatments was postponed until 2004. These more detailed experiments will enable the study of more irrigation treatments and the interaction of irrigation with alfalfa variety. This research will also evaluate in a drought situation whether it is better to cut off irrigations early or try to spread that water over the whole season. The six irrigation treatments are as follows.

Irrigation Treatments

1. Full irrigation (100% of ET)
2. Moderate deficit irrigation (66% of ET)
3. Severe deficit irrigation (33% of ET)
4. Early irrigation cutoff (June 1)
5. Moderate irrigation cut-off (July 15)
6. No irrigation

Fourteen different alfalfa varieties were studied representing a range of fall dormancy. Some of the varieties were bred for production under drought conditions.

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PRELIMINARY FINDINGS

Large-Scale Field Trials

Both Klamath Basin locations had a relatively high water table—wet soil occurred at about 3 feet at the sandy loam location and about 3.5–4 feet at the silt loam location. Therefore, soil moisture readings at the deepest depth evaluated (3 feet) did not respond as dramatically to the irrigation treatments as did the shallower depths.

Water application rates were determined by monitoring the flow rate from individual sprinklers and multiplying the flow rate by the number of hours of operation per irrigation. Considerably more water was applied at the silt loam site than the sandy loam site, reflecting differences in grower irrigation practices. The sandy loam soil was irrigated once between cuttings with approximately 5.5 inches of water per irrigation. The silt loam site was irrigated one to two times per cutting and received an irrigation in mid-October after the harvest season was completed. Therefore, the water savings associated with the irrigation cut-off treatments varied considerably between the two locations. Twenty-one inches and 11 inches of water were saved with the irrigation cut-off after the first cutting for the silt loam and sandy loam sites, respectively. This represents a considerable reduction in applied water, as most alfalfa fields in the Klamath Basin are only irrigated one or two times before first cutting (fields were only irrigated once before first cutting this year because of the moist spring).

Table 1. Water savings associated with deficit irrigation treatments at two alfalfa fields located in the Klamath Basin (2003).

	Water Savings (inches/acre)	
Irrigation Treatment	**Sandy loam site**	**Silt loam site**
No irrigation after 1st cutting	11.0	21.0
No irrigation after 2nd cutting	5.5	16.8

There was a visible difference in alfalfa growth between the fully irrigated plots and the plots with an early irrigation termination. However, even where irrigation was terminated there was still substantial alfalfa growth. Within an irrigation cut-off treatment, there was a high degree of variability in alfalfa growth between plots due to changes in soil texture and moisture holding capacity across the field.

The yield reduction resulting from early irrigation cut-off is shown in Tables 2 and 3. The fine sandy loam site in Malin was an older field with lower yield potential. Irrigation termination after first cutting reduced yield by 0.60 tons per acre over the second and third cuttings in 2003 and by 1.46 tons/A in 2004. Ceasing to irrigate after second cutting reduced third cutting yield by 0.29 tons in 2003 and 0.74 in 2004. The silt loam site was a younger alfalfa stand with higher yield potential. Four cuttings were made at this site each year. In 2003 second cutting yield declined from 1.24 to 0.95 tons per acre when irrigation was ceased. A similar decline in yield was observed in 2004 (from 1.14 to 0.89 tons/A). Third cutting yield in 2003 decreased from 1.36 tons per acre to 1.13 and 1.20 tons per acre when water was withdrawn before second and third cuttings, respectively. Only a 0.13 ton yield decrease occurred in 2004 for the same treatments. The total seasonal yield reduction from early irrigation termination was remarkably similar for the two years. Yield declined 0.71 and 0.70 tons per acre from cutting water off at first cutting in years 2003 and 2004, respectively. When was cut off after second cutting, yield decreased 0.53 tons per acre in 2003 and 0.48 tons per acre in 2004.

Table 2. The effect of irrigation cut-off on subsequent alfalfa yield on a fine sandy loam soil in Malin, Oregon (2003 & 2004).

2003	Yield (tons/acre)		
Irrigation Treatment	2nd Cut 7/22/03	3rd Cut 8/30/03	Total
Normal full-season irrigation	1.03	0.67	1.70
No irrigation after 1st cutting	0.88	0.22	1.10
No irrigation after 2nd cutting	1.03	0.38	1.41
LSD 0.05	NS	0.18	0.34

2004	Yield (tons/acre)		
Irrigation Treatment	2nd Cut 7/22/03	3rd Cut 8/30/03	Total
Normal full-season irrigation	1.53	1.33	2.86
No irrigation after 1st cutting	1.02	0.38	1.40
No irrigation after 2nd cutting	1.41	0.71	2.12

Table 3. The effect of irrigation cut-off on subsequent alfalfa yield on Capjac silt loam soil in Tulelake, California (2003 & 2004).

	Yield (tons/acre)			
Irrigation Treatment	2nd Cut 7/4/03	3rd Cut 8/5/03	4th Cut 9/11/03	Total
Normal full-season irrigation	1.24	1.36	1.21	3.81
No irrigation after 1st cutting	0.95	1.13	1.01	3.10
No irrigation after 2nd cutting	1.22	1.20	0.86	3.28
LSD 0.05	NS	NS	0.33	0.66

	Yield (tons/acre)			
Irrigation Treatment	2nd Cut 7/4/03	3rd Cut 8/5/03	4th Cut 9/11/03	Total
Normal full-season irrigation	1.14	1.60	1.26	4.00
No irrigation after 1st cutting	0.89	1.47	0.94	3.30
No irrigation after 2nd cutting	1.20	1.48	0.84	3.52

This yield reduction is not severe considering the amount of water saved. The high water table in all probability supplied some of the water needs of the alfalfa during the latter half of the season in the deficit-irrigated treatments. However, soil moisture from the perched water table may not be as accessible in a drought year, especially if the irrigation canals are not full and surrounding fields are not irrigated. These results may be typical for locations in the Intermountain region with a high water table. However, the yield reduction is much greater at sites without a high water table like the Scott Valley trial location (data not shown).

First cutting yield was taken in the spring of 2004, to document any carryover effects from the irrigation cut-off treatments the year before. There was no difference in first cutting yield at either of the two sites indicating that there was no detectable carryover effect from the early irrigation cut-off treatments. Stand was also assessed in spring the following year after the irrigation treatments were imposed. Stand density

was evaluated using visual ratings and by counting the number of stems per unit area. Both assessments indicated no stand difference between any of the treatments.

Small-Plot Intensive Trials

The preliminary results of the small-plot intensive trials with 14 alfalfa varieties and six different irrigation regimes have been disappointing. Data analysis for the first two cuttings indicated no significant differences in yield between the six irrigation regimes. There was a trend for decreased yield with the deficit-irrigation treatments over the season but the difference is very small (Figure 1.). The alfalfa in the deficit irrigation regimes apparently is able to meet much of its water needs from the perched water table, masking the effects of the irrigation treatments.

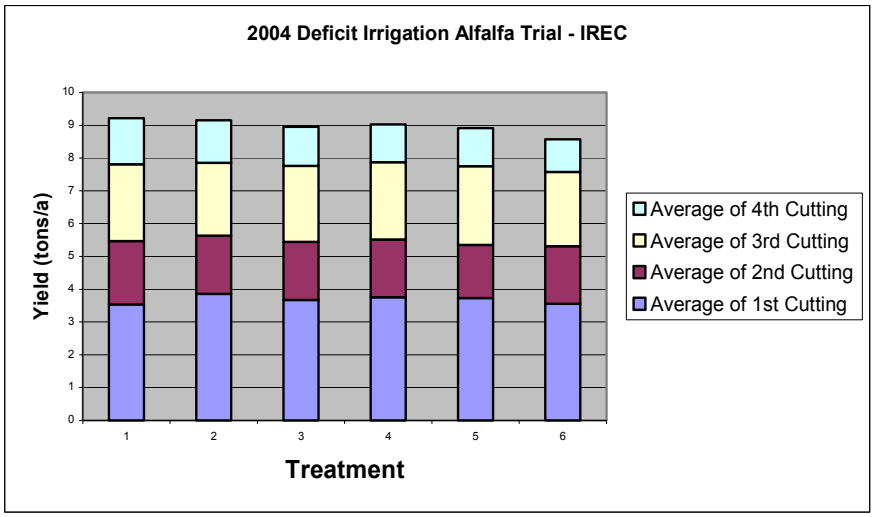

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Figure 1. The effect of six irrigation regimes on alfalfa yield at IREC. (2004)