DEFICIT IRRIGATION WITH ALFALFA: WHAT ARE THE ECONOMICS?

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Alfalfa lends itself to irrigation strategies where less water is applied than is needed by the crop for maximum yield (deficit irrigation). The crop may recover after irrigations are returned to normal if the water stress is not excessive. In this way, water may be used for other crops on the farm. Deficit irrigation of alfalfa has been practiced in the past and there is a body of research data on this practice. The purpose of this paper is to explore the economic implications of deficit irrigation of alfalfa.

PROFITABILITY

The profitability of deficit irrigation in alfalfa depends on yield, water application amount, hay price, cost of water, and other costs. Hay yield will usually decrease with deficit irrigation since less water is applied than needed by the crop for maximum yield. The decrease in water application amount will depend on the particular strategy employed, such as applying one instead of two flood irrigations, decreasing the amount of irrigation water applied per irrigation in a sprinkler or drip system, or cutting off irrigations for one or more cuttings. Hay price can change on an annual basis and typically fluctuates throughout the year with the highest price usually associated with the spring cuttings. The cost of water varies of course depending if the source is surface or groundwater or the depth of pumping in the case of groundwater. Other costs include those associated with establishment, fertilization, weed and insect control, and harvest.

PEST CONTROL

Deficit irrigation will reduce water cost but could also change cost of controlling insects or weeds in a positive or negative direction depending on the situation. For example, potato leafhopper and lygus bugs are attracted to crops under water stress, and these insects may need to be controlled with deficit irrigation but not under normal conditions. On the other hand, certain lepidopterous insects such as alfalfa caterpillar are not attracted to water stressed alfalfa, and a grower may decide not to control this pest under deficit irrigation unlike under normal conditions. Deficit irrigation could change weed control practices. An alfalfa crop under stress may not be as competitive with certain weeds, and additional herbicide applications may be required. However, under water stress, alfalfa is usually more competitive with most weeds since it is a deep-rooted crop, and deficit irrigation can be used a weed control practice.

HAY QUALITY

Deficit irrigation may change the quality of the hay produced. Water stress reduces stem growth relative to leaf growth and the leaf to stem ratio may be higher with deficit irrigation. Therefore,

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hay quality may actually be increased with deficit irrigation. However, if the water stress is severe enough where leaves are lost, hay quality from deficit irrigation may be reduced. Water stressed hay subjected to a visual hay quality determination may be considered lower in quality than hay grown with adequate water despite hay test results. In particular, the leaves in water stressed hay may detach more easily and the plant would be more likely to be at a more advanced stage of growth since water stress accelerates the time to reach bloom.

RESIDUAL EFFECTS

Deficit irrigation may have residual effects that could negatively affect the profitability of this practice. In other words, if yields do not fully recover or insect or weed problems are worse after full irrigation is resumed, then these would be residual effects of deficit irrigation. Stand loss and temporary or permanent yield loss after resumption of full irrigation is more likely with sandy soils or with a long duration of irrigation termination in regions with hot and dry weather conditions.

IRRIGATION WATER USE EFFICIENCY

Alfalfa is a high water use crop since it has a longer growth cycle than most crops. Alfalfa is usually very responsive to irrigation water and yield usually increases in a linear fashion with irrigation water application up to a certain point. So, on average, it is difficult to see how deficit irrigation will save money. The key is not to look at the annual growth cycle as a whole, but to look at individual cuttings. Irrigation water use efficiency (IWUE) is defined as the amount of hay produced per unit of irrigation water applied and can be expressed as tons of hay per foot of water. In the low elevation desert areas of Arizona and California, the IWUE in the summer is about half that in the spring. In other production regions, the trend of higher IWUE in the spring than the summer also holds true, but the differences between the seasons may not be as great as in warmer areas. So, practicing deficit irrigation during the times of year when IWUE is low would have less effect on income since the yields would be lower. Also, the hay price tends to be lower in the summer than spring further contributing to lessening effect on income. Precipitation can also have an effect on IWUE. Rainy seasons occur during the winter near the Pacific coast and in the summer in parts of Arizona, New Mexico, and Colorado. Deficit irrigation during rainy seasons may have less effect on yield than during the dry season.

RESEARCH STUDIES

Many research studies on deficit irrigation have been conducted and many show that deficit irrigation does not pay (Table 1). There are exceptions, of course, and that would be where water more water was applied than needed in the winter in Yuma, AZ (1) and Tucumcari, NM (4) or where irrigation water application was contributing to Phytophthora root rot in Las Cruces, NM (3). In most cases, for deficit irrigation to be “profitable” or lose less money than standard irrigation, the cost of water has to be higher or the value of the hay lower than what they are currently. For example, water cost may need to be $100-200 per acre-foot and hay price $50-100 per ton for deficit irrigation to make sense economically. At these water costs and hay prices, however, alfalfa probably would not be grown since the losses to produce the crop would be so great.

Table 1. Hay yield, water applied, irrigation water use efficiency (IWUE), and revenue change relative to control from various tests studying deficit irrigation strategies. The change in revenue was calculated by assuming a hay price of $200 per ton, a water cost of $50 per acre-foot, and a harvest cost of $50 per acre.

Reference	Location	Years	Treatment	Yield	Water	IWUE	Revenue change
				T/A	ft	T/A/ft	$
1	Yuma, AZ	1991-92	Control	7.64	11.02	0.69	0
			Jul-Oct cutoff	4.82	6.43	0.75	-194
			Nov-Feb cutoff	7.54	8.27	0.91	123
1	Maricopa, AZ	1990-92	Control	7.51	4.98	1.51	0
			Aug-Sep cutoff	6.66	3.90	1.71	-74
			Aug-Mar cutoff	4.36	2.79	1.56	-363
2	Holtville, CA	1991-93	Control	5.44	4.10	1.33	0
			1 irrigation/cut	4.84	3.97	1.22	-85
			Jul-Aug cutoff	3.84	3.32	1.16	-202
			Jul-Sep cutoff	3.16	2.80	1.13	-278
3	Las Cruces, NM	1984-86	Control	8.70	5.00	1.74	0
			Aug-Oct cutoff	9.20	3.30	2.79	160
4	Tucumcari, NM	1998-01	Winter irrigated	9.64	5.41	1.78	0
			Not winter irrigated	9.32	2.95	3.16	75
5	Ft Collins, CO	2007-09	Control (limited each cutting)	3.45	1.25	2.76	0
			Late June -winter	1.80	0.75	2.40	-223
6	Powell, WY	2012-13	100% ET	7.75	1.52	5.09	0
			75% ET	6.06	1.18	5.11	-238
			50% ET	3.81	0.86	4.43	-559
			25% ET	1.98	0.52	3.79	-816

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