SUMMER AND WINTER TERMINATION OF IRRIGATION

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ABSTRACT

Alfalfa water use has been scrutinized due to demands of municipalities and needs of other crops. The objective of this study was to determine the influence of summer and winter irrigation termination for alfalfa grown on soil types and locations where this information is not available. Irrigations were terminated in the summer and/or winter for alfalfa grown in Yuma and Maricopa, AZ. Summer irrigation termination (July through September/October) permanently damaged the alfalfa crop on the sand soil at Yuma but not on the sandy loam soil at Maricopa. Terminating irrigation in the summer plus winter (July through February) reduced yield per cutting from 1.26 to 0.81 tons per acre at Maricopa. Winter irrigation termination (October through February) at Yuma reduced yield slightly but required eight fewer irrigations than normal. Based on the results of this study 1.) summer irrigation termination is not recommended on sands or very sandy soils, 2.) prolonged irrigation termination from the summer through the winter is not recommended, and 3.) summer or winter irrigation termination can result in minimal yield loss and considerable water savings.

INTRODUCTION

Alfalfa grows nearly all year in the low elevation desert valleys of the Southwestern U.S. Therefore, alfalfa has one of the highest annual water requirements of any crop grown in this area. Alfalfa water requirements have been scrutinized due to the needs of municipalities and of other crops. Alfalfa is a prime candidate for reduced irrigation application since water can be withheld from the crop during a growth cycle with minimal effects on growth after the crop is re-irrigated under certain conditions (Schonhorst et al., 1963). Skipping irrigations with most crops will usually affect yield over an annual cycle, rather than a monthly cycle as with alfalfa. For example, skipping an irrigation of corn at critical periods will decrease the yield for the entire season while skipping an irrigation of alfalfa will affect yield for a single cutting.

Withholding summer irrigation was a common practice in the Southwest and similar growing areas approximately 30 or more years ago, and is still practiced on some farms today. Withholding summer irrigation can result in less stand loss due to scald, fewer problems from summer grasses, and allows water to be applied to other crops. The advent of improved land leveling techniques and effective herbicides in the early 1960's eliminated some of the problems of growing alfalfa during the summer in the irrigated Southwest.

Some of the earliest work comparing summer irrigated and summer dormant alfalfa was conducted at Mesa, AZ by Schonhorst et al. (1963), who demonstrated that alfalfa stands can actually benefit from withholding irrigation water during the summer. Stands and subsequent yield were not damaged by withholding summer irrigation in studies conducted in Tucson (Schneiter, 1973), Cyprus (Metochis and Orphanos, 1981), New Mexico (Wilson et al., 1985).
the San Joaquin Valley of California (Frate et al., 1988) and Nevada (Guitjens, 1988). These studies did show that the alfalfa may require a cutting to fully recover from previous irrigation termination.

OBJECTIVES

1. Re-evaluate yield and stand persistence of alfalfa grown without summer irrigation in Central Arizona similar to the work of Schonhorst et al. (1963) but on a lighter soil type more representative of the state.

2. Evaluate yield and stand persistence of alfalfa grown without irrigation from mid-July to February similar to a treatment imposed in the work of Frate et al. (1988) but conducted in Central Arizona which has more summer rainfall, less winter rainfall, and has a higher water demand compared to Frate’s Central Valley location.

3. Evaluate yield and stand persistence of alfalfa grown without irrigation from October to March. Winter irrigation termination has not been considered in the past since alfalfa water use is low during the winter, demand for irrigation water by municipalities and other crops is also low during the winter, and cost of irrigation water is less during the winter in some cases. However, haymaking is difficult during the winter and hay produced during this time period is often off-grade.

4. Evaluate stand persistence of alfalfa grown without summer irrigation on a sand in Yuma. This represents a worst case scenario for stand persistence due to the low water holding capacity of sand and the low average summer rainfall in Yuma.

MATERIALS AND METHODS

Yuma

The Yuma Mesa Agricultural Center was one of the two locations where alfalfa irrigation termination was studied. On 26 September 1990, CUF 101 alfalfa was seeded at a rate of 27 pounds per acre on a 10 acre field. The field was divided into nine plots of slightly more than 1 acre each. The entire field was irrigated normally by border-flood irrigations until 1 July 1991. Three irrigation treatments replicated three times were imposed: 1.) Summer termination - irrigation terminated in July 1991 and resumed on 11 November 91, 23 irrigations for a total of 10.5 feet, 2.) Winter termination - irrigation terminated in October 1991 and resumed on 4 March 92, and, 25 irrigations for a total of 11.5 feet, 3.) Normal irrigation - no interruption of irrigations, 33 irrigations for a total of 15.1 feet. The alfalfa was harvest nine times from 21 March 91 to 13 March 92. Yield was measured on five subplots per plot measuring 1/10,000 acre. Stand was estimated on 19 March 92 by counting the number of crowns in ten 1/10,000 acre areas within each plot.
An alfalfa irrigation termination study was also conducted at the Maricopa Agricultural Center. Alfalfa was seeded during October of 1989 in eight borders approximately 0.65 acre each. Each plot or border was irrigated using the border-flood method. The following irrigation treatments were replicated three times, except for the normal irrigation which was replicated twice: 1.) Summer termination - irrigation terminated in mid-July and resumed in early October. 2.) Summer and winter termination - irrigation terminated in mid-July and resumed the following year in February, 3.) Normal irrigation - no interruption of irrigations. These irrigation treatments were started during the summer of 1990 and continued through the summer of 1992. Hay produced on each plot was weighed and adjusted to 12% moisture. Stand was estimated from a 32 square foot area by counting "apparent" crowns during the trial and by counting "actual" crowns dug at the end of the trial.

RESULTS AND DISCUSSION

The influence of irrigation termination on yield and stand appears to be site and situation specific. In Yuma on a sand soil, termination of irrigation during the summer harmed the stand and reduced yields (Table 1 and Fig. 1). Yields were decreased from July through October when irrigations were withheld, as expected. However, the crop did not recover when re-watered and damage from summer termination of irrigation appeared permanent due to stand loss. The below-ground portions of the alfalfa are tolerant of water stress, but are not indestructible as these results demonstrate. Summer irrigation termination at Maricopa on a sandy loam soil was not detrimental to final stand or total yield (Table 2). Yields of certain individual cuttings were decreased, however (Fig. 2). Yields during the summer termination stage were close to zero. Yields recovered immediately after irrigations resumed in October of 1990, but after irrigations resumed in 1991, yields of the summer termination treatment did not recover until three cuttings later in April of the following year.

The combination of summer and winter irrigation termination at Maricopa reduced total yield considerably but not final stand (Table 2). Yields of individual cuttings after irrigation termination from July 1990 to February 1991 did not recover until five cuttings later in July of 1991. Irrigations were terminated in July of 1991 for this treatment and resumed in February of 1992 for a second cycle of irrigation termination. Yields never did recover after the second cycle of summer and winter irrigation termination. "Apparent" stand, which is an estimate of stand based on crowns visible above-ground, was measured during the course of the experiment (Fig. 3). "Apparent" stand was decreased by summer and winter irrigation termination after the treatment was imposed for the first time. After the second cycle of summer and winter irrigation termination in May of 1992, "apparent" stands were similar for all treatments.

Irrigation termination during the winter may be an alternative sub-optimal irrigation strategy. Yields were similar to that obtained with normal irrigation although considerably less water was applied (Table 1). Yields were reduced for the winter termination treatment for the December 27 cutting, which was a light cutting anyway (Fig. 1). Yields at the March 13 cutting were not reduced by lack of irrigation in January and February apparently due moisture contributed from precipitation.
Many factors contribute to performance and survival of alfalfa plants after termination of irrigation including soil type, rainfall, temperature, age of stand, and availability of subsoil moisture. A major factor contributing to stand loss with summer irrigation termination appears to be soil type according to the results of this study. This study demonstrates that withholding summer irrigation from alfalfa as a water conservation measure can not be recommended on sands or very sandy soils due to the possibility of permanent crop damage. Prolonged irrigation termination from July through February can also not be recommended. Winter irrigation termination may be a viable sub-optimal irrigation strategy. Hay production is difficult during the winter due to rainfall, frost, and poor curing conditions. Also, applications of phosphorus, insecticides for alfalfa weevil control, and herbicides are often necessary to maintain optimum production during the winter months.

The benefits or detriments of summer or winter irrigation termination and other sub-optimal irrigation strategies are site specific. Water costs, price of hay, soil moisture, weather, potential for temporary or permanent crop damage, alternatives uses of the water, fixed costs, and other factors must be considered before choosing a sub-optimal irrigation strategy.

| Table 1 | Irrigation termination and yield, irrigation efficiency, and stand after nine cuttings at Yuma. |
|-------------------|----------------------------------|----------|-----------------|------------------|
| Irrigation Termination | Hay Yield | Water Applied | Irrigation Efficiency | Stand |
| | tons/acre | ac. ft./acre | tons/ac. ft. | plants/ft² |
| Normal | 9.3 | 15.1 | 0.62 | 4.0 |
| Winter | 9.1 | 11.5 | 0.79 | 4.1 |
| Summer | 6.1 | 10.5 | 0.58 | 1.5 |

| Table 2 | Irrigation termination and average hay yields and final stand at Maricopa |
|-------------------|----------------------------------|------------------|
| Irrigation Termination | Hay Yield per Cutting | Final Stand |
| | tons/acre | plants/ft² |
| Normal | 1.26 | 3.42 |
| Summer | 1.14 | 4.06 |
| Summer and Winter | 0.81 | 4.00 |
LITERATURE CITATIONS


Fig. 1. Hay yields for Yuma.
Fig. 2. Hay yields for Maricopa.

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<th>Normal irrigation</th>
<th>Summer termination</th>
<th>Summer and winter termination</th>
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HAY YIELD (tons/acre)

April 90, May 90, June 90, July 90, September 90, November 90, March 91, April 91, May 91, June 91, July 91, September 91, November 91, March 92, April 92, May 92.
Fig. 3. "Apparent" stand over time.

- Normal irrigation
- Summer termination
- Summer and winter termination