

# Alfalfa Irrigation Termination, Maricopa

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## Abstract

*Alfalfa irrigation is often withheld as a water conservation measure in Arizona. The objective of this research was to test the hypothesis that alfalfa can be permanently damaged by withholding irrigation water. Irrigation was terminated during the summer (July or August through September) or summer through winter (July or August through mid-March) on a Casa Grande sandy loam at Maricopa. Irrigation termination at Maricopa was not detrimental to stand although hay yields were depressed from 1.47 to 1.28 tons per acre following the second cycle of summer irrigation termination and from 1.57 to 1.23 tons per acre per cutting following summer through winter irrigation termination. Alfalfa water use was reduced by irrigation termination even after irrigation was resumed. Total nonstructural carbohydrates in the roots were never less than the control during irrigation termination but decreased relative to normally irrigated alfalfa when irrigation resumed.*

## Introduction

Withholding summer irrigation was a common practice 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. However, the advent of improved land leveling techniques and effective herbicides in the early 1960's reduced the effect of scald and weeds leading many growers to resume summer irrigation.

Some of the earliest research on alfalfa irrigation during the summer was conducted at Mesa, AZ by Schonhorst et al. (1963), who demonstrated that alfalfa stands decline less if summer irrigation is withheld than if irrigated normally. Stands and subsequent yield were not damaged by withholding summer irrigation in studies conducted in other locations including Tucson, AZ (Schneider, 1973), Cyprus (Metochis and Orphanos, 1981), New Mexico (Wilson et al., 1983), the San Joaquin Valley of California (Frate et al., 1988), and Nevada (Guitjens, 1988). These studies did show that alfalfa grown in the summer without irrigation may require up to one growth cycle after irrigation is resumed for yields to recover compared to alfalfa that had been irrigated during the summer.

The objective of this research was to test the hypothesis that alfalfa yields and stands can be permanently damaged by withholding irrigation, despite the evidence in the literature to the contrary. Maricopa higher evaporative demand and/or coarser soil texture compared to sites where irrigation termination has been tested and reported in the literature in the past.

## Materials and Methods

An alfalfa irrigation termination study was also conducted at the Maricopa Agricultural Center on a Casa Grande sandy loam soil. 'CUF-101' was seeded on 15 October 89 in eight plots approximately 0.6 acre each. Each plot was irrigated using the border-flood method according to standard farm practice until irrigation treatments were imposed. The following irrigation treatments were replicated three times, except for the normal irrigation which was replicated twice, in a completely randomized design (Table 1): 1.) Summer termination - irrigation terminated in July or August through September, 2.) Summer and winter termination - irrigation terminated in July or August through mid-March, 3.) Normal irrigation - no interruption of irrigation. Hay was produced on each plot using a commercial windrower, rake, and baler. Hay from the entire plot was weighed and adjusted to 12% moisture. Stand was estimated several times during the experiment by counting the number of crowns in a permanent 32 ft<sup>2</sup> area. Alfalfa water use was calculated from soil moisture depletion measurements to a depth of 9 ft in 1 ft

increments using a neutron probe. Total nonstructural carbohydrates were determined periodically in the roots sampled from a 1 ft<sup>2</sup> area using a modified Nelson's assay (Southgate, 1976).

## Results and Discussion

Summer irrigation termination did not have as dramatic an effect on total yield or final plant density (Tables 2 and 3). Yields of certain individual cuttings were decreased especially during the summer termination stage. Yields recovered in the first regrowth after irrigation resumed in October 1990, but not after irrigation resumed in October 1991. Lack of recovery from summer irrigation termination in 1991 but not 1990 may possibly be due to the fact that one irrigation was skipped in the summer of 1990 while two irrigations were skipped in the summer of 1991. The combination of summer and winter irrigation termination considerably reduced total yield but not final stand. Yields of individual cuttings after irrigation termination from August 1990 through mid-March 1991 did not recover compared to normally irrigated alfalfa until four cuttings later in July 1991. Irrigation was terminated in July 1991 for this treatment and resumed in February 1992 for a second cycle of irrigation termination. Yields never did recover after the second cycle of summer and winter irrigation termination. 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 1992, stands were similar for all treatments and remained so through the end of the experiment.

Water use has not been reported in the literature for irrigation termination treatments but deficit irrigation has been shown to result in decreased water use (Bauder et al., 1978; Grimes et al., 1992). Irrigation termination reduced daily water use as expected during the termination period (Table 4). When irrigation was resumed in October for the summer termination treatment, daily water use was less than alfalfa normally irrigated during the summer, although a reduction in yield was not detected. Summer irrigation termination may have conditioned the alfalfa plant to use water more conservatively.

Water-stressed alfalfa has been shown to have higher levels of total non-structural carbohydrates in the roots compared to well-watered alfalfa (Cohen et al., 1972; Hall et al., 1988; Rice et al., 1989). High summer temperatures can also deplete carbohydrate reserves particularly with frequent harvests (Feltner and Massengale, 1965; Robison and Massengale, 1968). Irrigation termination at Maricopa did not deplete root carbohydrates during the summer, but reduced carbohydrate levels were detected during the fall (Table 5). Some carbohydrates are obviously required to maintain the basal metabolism of the root, but the amount must be small compared to the total amount available at the beginning of the irrigation termination cycle and the amount needed to produce new growth. Carbohydrate levels in irrigation termination treatments drop disproportionately compared to normally irrigated controls once irrigation is resumed after irrigation termination and the plant starts regrowing. This may be due to the fact that there are fewer live buds on plants in irrigation termination treatments and these need to be reformed.

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Table 1. Irrigation and rainfall.

| Date               | Irrigation water applied |        |                      | Precipitation<br>since last<br>irrigation |
|--------------------|--------------------------|--------|----------------------|---|
|                    | Irrigation termination   |        |                      |   |
|                    | None                     | Summer | Summer<br>and winter |   |
| ----- inches ----- |                          |        |                      |   |
| 15 Oct 89          | 7.99                     | 7.99   | 7.99                 |   |
| 09 Mar 90          | 7.01                     | 7.01   | 7.01                 | 2.56                                      |
| 14 Apr 90          | 6.81                     | 6.81   | 6.81                 | 0.12                                      |
| 15 May 90          | 7.99                     | 7.99   | 7.99                 | 0.24                                      |
| 08 Jun 90          | 7.01                     | 7.01   | 7.01                 | 0.12                                      |
| 29 Jun 90          | 6.50                     | 6.50   | 6.50                 | 0.04                                      |
| 01 Aug 90          | 6.50                     | 6.50   | 6.50                 | 3.07                                      |
| 06 Sep 90          | 5.91                     | 0.00   | 0.00                 | 1.57                                      |
| 04 Oct 90          | 6.50                     | 6.50   | 0.00                 | 0.24                                      |
| 26 Oct 90          | 6.50                     | 6.50   | 0.00                 | 0.00                                      |
| 19 Mar 91          | 6.81                     | 6.81   | 6.81                 | 3.50                                      |
| 20 Apr 91          | 6.50                     | 6.50   | 6.50                 | 1.18                                      |
| 25 May 91          | 6.81                     | 6.81   | 6.81                 | 0.00                                      |
| 13 Jun 91          | 6.81                     | 6.81   | 6.81                 | 0.00                                      |
| 10 Jul 91          | 6.81                     | 6.81   | 6.81                 | 0.00                                      |
| 05 Aug 91          | 6.81                     | 0.00   | 0.00                 | 0.16                                      |
| 03 Sep 91          | 6.81                     | 0.00   | 0.00                 | 0.51                                      |
| 09 Oct 91          | 6.81                     | 6.81   | 0.00                 | 0.24                                      |
| 14 Nov 91          | 6.69                     | 6.69   | 0.00                 | 1.18                                      |
| 23 Mar 92          | 7.01                     | 7.01   | 7.01                 | 5.31                                      |
| 27 Apr 92          | 6.81                     | 6.81   | 6.81                 | 2.01                                      |
| 05 May 92          | 5.98                     | 5.98   | 5.98                 | 0.43                                      |
| 08 Jun 92          | 6.81                     | 6.81   | 6.81                 | 1.22                                      |
| 16 Jul 92          | 6.50                     | 6.50   | 6.50                 | 0.43                                      |
| 13 Aug 92          | 6.81                     | 6.81   | 6.81                 | 1.34                                      |
| SUM                | 169                      | 150    | 123                  | 25  |

Table 2. Irrigation termination effects on hay yield.

| Date                      | Hay yield              |        |                   | FLSD (10%) |
|---------------------------|------------------------|--------|-------------------|------------|
|                           | Irrigation termination |        |                   |            |
|                           | None                   | Summer | Summer and winter |            |
| ----- tons per acre ----- |                        |        |                   |            |
| 21 Aug 90                 | 0.63                   | 0.07   | 0.04              | 0.10       |
| 03 Dec 90                 | 1.24                   | 1.20   | 0.04              | 0.11       |
| 08 Mar 91                 | 0.93                   | 0.77   | 0.11              | 0.35       |
| 26 Apr 91                 | 1.61                   | 1.71   | 1.21              | 0.10       |
| 04 Jun 91                 | 1.81                   | 1.69   | 1.33              | NS         |
| 25 Jun 91                 | 1.29                   | 1.24   | 1.15              | 0.09       |
| 24 Jul 91                 | 1.15                   | 1.19   | 1.08              | NS         |
| 22 Aug 91                 | 0.32                   | 0.05   | 0.07              | 0.05       |
| 07 Nov 91                 | 1.23                   | 0.83   | 0.06              | 0.26       |
| 21 Feb 92                 | 1.07                   | 0.92   | 0.13              | 0.07       |
| 21 Apr 92                 | 1.67                   | 1.57   | 1.07              | 0.28       |
| 27 May 92                 | 1.91                   | 1.80   | 1.56              | 0.06       |
| Mean                      | 1.24                   | 1.08   | 0.66              | 0.13       |

Table 3. Irrigation termination effects on plant density.

| Date                               | Plant density          |        |                   | FLSD (10%) |
|------------------------------------|------------------------|--------|-------------------|------------|
|                                    | Irrigation termination |        |                   |            |
|                                    | None                   | Summer | Summer and winter |            |
| ----- plants per square foot ----- |                        |        |                   |            |
| 16 Aug 90                          | 12.3                   | 11.2   | 12.5              | NS         |
| 18 Mar 91                          | 10.6                   | 9.5    | 7.2               | 2.5        |
| 03 Sep 91                          | 8.8                    | 9.4    | 7.5               | NS         |
| 29 May 92                          | 5.0                    | 4.7    | 4.6               | NS         |
| 23 Oct 92                          | 3.4                    | 4.1    | 4.0               | NS         |

Table 4. Irrigation termination effects on daily water use .

| Date                       | Daily water use        |        |                   | FLSD (10%) |
|----------------------------|------------------------|--------|-------------------|------------|
|                            | Irrigation termination |        |                   |            |
|                            | None                   | Summer | Summer and winter |            |
| ----- inches per day ----- |                        |        |                   |            |
| 16 Aug - 20 Aug 90         | 0.275                  | 0.145  | 0.164             | 0.086      |
| 21 Aug - 03 Sep 90         | 0.122                  | 0.065  | 0.077             | 0.030      |
| 04 Sep - 26 Sep 90         | 0.242                  | 0.034  | 0.028             | 0.026      |
| 09 Oct - 22 Oct 90         | 0.155                  | 0.149  | 0.030             | 0.031      |
| 30 Oct - 12 Nov 90         | 0.192                  | 0.094  | 0.006             | 0.054      |
| 13 Nov - 13 Dec 90         | 0.074                  | 0.057  | 0.006             | 0.004      |
| 18 Dec - 08 Jan 91         | 0.063                  | 0.051  | 0.042             | 0.013      |
| 09 Jan - 17 Mar 91         | 0.079                  | 0.056  | 0.023             | 0.010      |

Table 5. Irrigation termination effects on total nonstructural carbohydrates.

| Date      | Total nonstructural carbohydrates |        |                   | FLSD (10%) |
|-----------|-----------------------------------|--------|-------------------|------------|
|           | Irrigation termination            |        |                   |            |
|           | None                              | Summer | Summer and winter |            |
|           | -----%                            |        |                   |            |
| 07 Aug 90 | 19.5                              | 21.0   | 20.8              | NS         |
| 16 Aug 90 | 16.8                              | 22.5   | 28.4              | 5.0        |
| 21 Aug 90 | 29.7                              | 30.7   | 31.9              | NS         |
| 28 Aug 90 | 32.9                              | 36.6   | 34.0              | NS         |
| 04 Sep 90 | 27.1                              | 31.8   | 30.4              | NS         |
| 27 Sep 90 | 36.9                              | 27.5   | 31.9              | NS         |
| 02 Oct 90 | 38.2                              | 29.4   | 33.0              | NS         |
| 09 Oct 90 | 42.9                              | 30.4   | 34.4              | NS         |
| 16 Oct 90 | 47.1                              | 19.1   | 32.9              | 7.3        |
| 23 Oct 90 | 38.4                              | 19.7   | 37.9              | NS         |
| 30 Oct 90 | 41.5                              | 33.8   | 30.5              | 7.2        |
| 06 Nov 90 | 40.9                              | 24.0   | 27.7              | 6.3        |
| 13 Nov 90 | 8.8                               | 6.1    | 15.0              | 5.9        |
| 04 Dec 90 | 10.4                              | 9.1    | 13.4              | NS         |
| 14 Dec 90 | 42.1                              | 40.3   | 36.7              | NS         |
| 17 Dec 90 | 42.5                              | 38.9   | 47.7              | 5.8        |
| 09 Jan 91 | 35.2                              | 31.9   | 42.1              | 6.1        |
| 18 Mar 91 | 43.2                              | 41.6   | 36.0              | 5.8        |
| 30 Apr 91 | 33.2                              | 30.7   | 33.0              | NS         |
| 03 Sep 91 | 27.6                              | 29.7   | 30.4              | NS         |
| 26 Nov 91 | 36.1                              | 26.6   | 36.3              | 8.7        |
| 06 Mar 92 | 33.9                              | 29.2   | 35.5              | NS         |
| Mean      | 30.8                              | 26.5   | 30.2              | 2.7        |