MANAGING ALFALFA UNDER LOW WATER OR DROUGHT CONDITIONS

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CHALLENGE QUESTIONS

- What must be maintained on alfalfa to increase survival during drought?
- What other harvest management factor will affect alfalfa survival?
- Name one factor producers should consider before plowing out a uniform alfalfa stand during drought.
- All other things being equal, what single factor might have the greatest effect on alfalfa yield?
- When should irrigations be concentrated to maximize water use efficiency?
- When should irrigations be applied to reduce weed competition?
- What other factors should be considered for drought management of alfalfa?
- What is your best source of information regarding alfalfa management in any situation?

INTRODUCTION

There are several aspects to managing alfalfa during drought, or periods of limited irrigation, all of which apply whether or not the alfalfa is drought stressed (Lauriault et al., 2009). Most of these will be more related to stand longevity – helping the alfalfa to ride out the drought and still likely be productive once water is available again. The points covered in this session are: 1) Harvest Management; 2) Variety Selection; 3) Fertility; 4) Weed Management; 5) Water Management

Harvest Management

Harvest management is often the easiest factor to control, when the weather cooperates. Alfalfa matures faster when drought stressed but, quality doesn't decline as fast so it should test the same, or possibly higher at more mature stages. During and after periods of stress, the harvest interval should be increased to allow more time for recovery. Harvest should not be delayed too long, though, because there is a point after which the quality will decline rapidly. Also, growth of crown buds might be induced causing damage to the regrowth during harvesting. Cutting height should be raised for standard hay varieties to leave a 6- to 8-inch stubble with leaves so the plant can continue to make sugar and not rely on root reserves as much for energy. A 6-week autumn rest period also is needed to restock root energy.

Variety Selection

Proper variety selection is actually the first step in managing alfalfa through drought. Newer varieties with grazing or traffic tolerance have deeper set crowns, which protects against damage. They also maintain leaf material below 6 inches so they can be harvested lower. Hybrid alfalfas also have these traits. These varieties are also more upright growing than the older grazing 'tolerant' varieties so yield is not sacrificed due to harvest avoidance.

Disease and insect problems are exacerbated by drought and vice versa. Diseases in alfalfa are hard to fight once they occur. The best protection is to plant only improved varieties that have at least an "R" rating to the diseases and insects that are prevalent in the area. Insects inflict damage that weakens the plants making them more susceptible to other problems like disease, freeze damage, and drought. Insects that have arisen as pests of alfalfa in recent years include beet armyworm, cutworm, and cowpea aphid. Armyworm and cutworm generally are prevalent in alfalfa during summer, but can appear at most anytime. Neither is host specific and can move into an alfalfa field from a wide range of other crops and weeds. Cowpea aphid appears very early in the spring, when the alfalfa is just greening up after winter. Damage at this time can destroy even a healthy stand because plants have nearly depleted root reserves and are relying on photosynthesis for growth. Cowpea aphids often appear before sufficient beneficial insects are present to keep them under control. Consequently, insecticides are about the only control option. Delaying treatment is extremely risky.

Fertility

Fertility is another concern during drought. It is difficult to pour money out on the ground knowing that the immediate returns will not be as great, but the alfalfa must be fed if it is going to persist. Soil testing before planting and every two to three years is important, but it is even more critical during drought. The difference now is that, because there's less water to promote growth, less of the fertilizer will be taken up by plants and lower levels are needed to keep from building up soil salinity. Boron also should be monitored because dry weather enhances deficiencies of that nutrient.

Weed Management

Weeds tend to be more of a problem in drought because they are better adapted to rapid germination and speedy growth and can out-compete even alfalfa for water and nutrients at the surface. Research indicates that it is best to apply fertilizers in fall or winter to reduce weed competition. Also, pre-emergent herbicide applications in the fall and late winter should help reduce fertilizer and water loss to winter weeds. It is also now recommended that irrigation be delayed after harvest until the canopy closes to reduce competition by weeds that do germinate. Maintaining the 6 to 8-inch stubble with leaves also will help the alfalfa be more competitive.

Weeds in alfalfa will be easier to control when the Roundup Ready varieties become available again this year. However, the effects of herbicides on weeds and alfalfa could be different under drought conditions and care must be taken to prevent the development of super weeds that also become Roundup resistant.

Water Management

Irrigation management has a great effect on seasonal yields. Without sufficient water, alfalfa goes dormant, or greatly reduces growth. Alfalfa is a cool-season crop producing most of its yield when the soils warm up in spring. In rainfed areas yield declines across the season. This is partially due to an increase in temperature, a decrease in precipitation, and shortening days. Irrigation is used to force alfalfa to produce during the summer in the western USA. Figure 1 compares alfalfa production under high and low precipitation in rainfed conditions and under irrigation in semiarid areas.

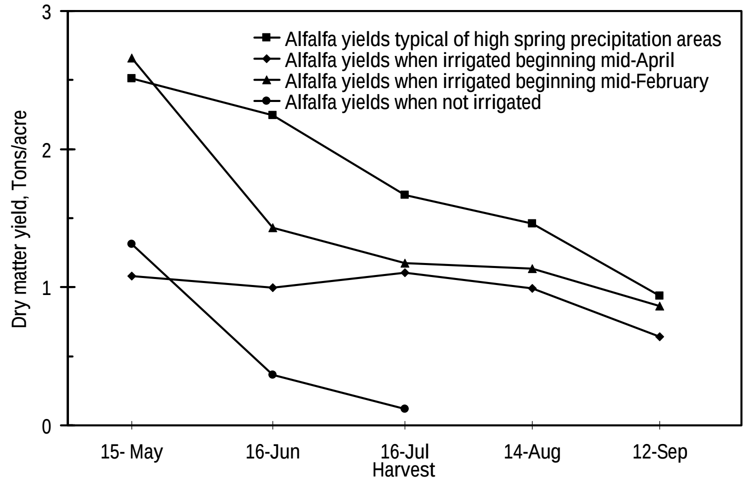

Figure 1. Dry matter yields of alfalfa under various growing conditions. Data for the high spring precipitation area is from Lexington, Kentucky (46 inches annual precipitation) and the irrigated and not irrigated data is from Tucumcari, New Mexico (16.5 inches annual precipitation).

Effect of Season

While alfalfa yields are generally higher in the spring, the water requirement is lower at that time demonstrating the greater water use efficiency in the spring compared to summer. It may not be feasible, or even possible to apply enough water during summer to meet alfalfa's water requirement. Consequently, it is best to maintain a full soil moisture profile during the spring so that the deeper water will still be available in the summer to allow for canopy closure after harvest that reduces weed competition before irrigation. It is critical to know what the water holding capacity, including depth of the soil actually is to prevent over application and water loss. The Cooperative Extension Service and Natural Resource Conservation Service should both be able to help determine what kinds of soils are on the farm, including their water holding capacities and other limitations, so management can be optimized.

Effects of Water Quantity

Alfalfa typically uses about 100 gallons of water per pound of dry matter produced or about 7.5 acre-inches per ton depending on where you are and the time of year. New Mexico data from Las Cruces, which gets about 10 inches of precipitation per year, indicates that there is no economic advantage to applying more than 40 inches of irrigation per year to alfalfa (Libbin et al., 1993). Table 1 summarizes of some alfalfa research conducted at NMSU's Agricultural Science Center in Tucumcari.

For the data in Table 1, irrigation water was not available in 2003 and 2004, and in 2002, it was a 3-inch allocation during which water available for only 6 weeks. Still, some return can be gained from alfalfa during drought, although productivity will be lower and yields below 0.5 tons/acre will probably not pay for mechanical harvesting (Orloff and Hansen, 2008); although, they might be valuable for light grazing if a 6-inch canopy can be maintained. The 1997 irrigated and non-irrigated tests shown in Table 1 included identical varieties and were in the same soil type, which doesn't have a very high water holding capacity. The 1997 Fall Dormancy and 2001 Variety tests were in a similar soil that has twice the water holding capacity. The 1999 Variety test in Table 1 was in a sub-irrigated area. The non-irrigated test at Tucumcari had been furrow-irrigated once after planting to promote germination. After four years only alfalfa remained (red, strawberry, and white clover, sainfoin, cicer milkvetch, birdsfoot trefoil, and crownvetch also had been planted). Stand decline did not occur until after 3 years of no irrigation. The irrigated study at Tucumcari had been furrow-irrigated to promote establishment and prior to the growth cycle for each of six cuttings per year. An Arizona study (Ottman et al., 1996) showed that stands were reduced by 2/3 in sand, while in sandy loams there was no stand reduction. The soils in the all studies at Tucumcari were fine sandy loams.

Table 1. Annual precipitation and alfalfa yields (tons/acre) from various tests at Tucumcari, NM.

		Test				
		1997			1999	2001
Year	Precipitation, inches	Irrigated	Non-irrigated	Fall Dormancy	Variety Test	Variety Test
1998	17.7	-	-	8.22^{6}	-	-
1999	18.7	3.78^{6}	1.43^{3}	7.51^{6}	-	-
2000	12.2	4.18^{6}	0.35^{1}	9.13^{6}	-	-
2001	14.6	7.02^{6}	1.79^{3}	7.97^{6}	9.04^{6}	-
2002	15.4	-	-	-	7.94^{6}	3.62^{3}
2003	15.6	-	-	-	5.87^{5}	0.52^{1}
2004	21.9	-	-	-	3.92^{5}	0.40^{1}

The long-term average rainfall at Tucumcari is 16.5 inches.
Superscripts indicate how many harvests were taken.

Irrigation Timing (When Available)

In another study at Tucumcari, various cuttings were furrow-irrigated to determine when water could possibly be saved. The test was sown in late summer 2005 and fully irrigated in 2006 to ensure establishment. There were six cuttings that year and the test was furrow-irrigated using similar amounts of water once prior to each harvest, usually soon after the previous cutting, except the first irrigation, which was applied in mid-April. No differences in yield existed among treatments in 2006 because the treatments had not been imposed.

The irrigation termination treatments were imposed from 2007 through 2009. There was a difference between years, but no interaction between years and irrigation treatments. Figure 2 gives the average yields across years. As in 2006, there were six cuttings each year and similar amounts of irrigation water were applied with each irrigation.

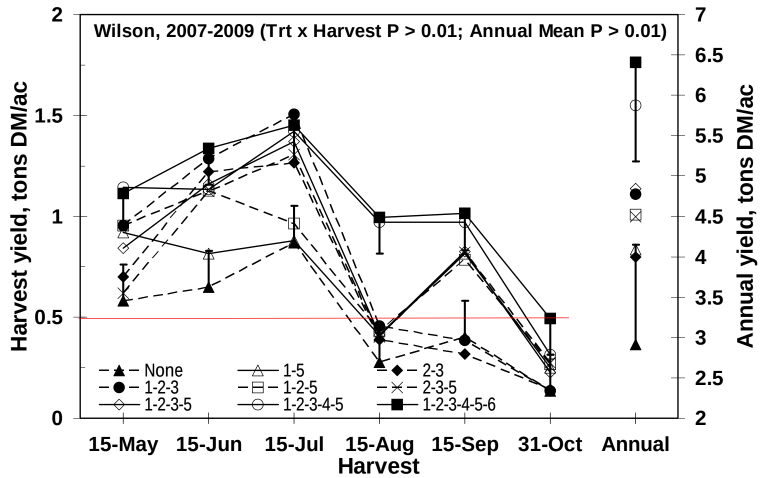

Figure 2. Dry matter yields of furrow-irrigated alfalfa under various summer irrigation termination strategies. Data series numbers in the legend indicate which cuttings were irrigated. Vertical bars indicate how much yield it takes for two treatments to be different within a cutting or for annual yield.

Again, alfalfa is more water use efficient through early summer as indicated by the higher yields at that time for the same amount of water (Figure 2). These spring yields would be much higher if irrigation had been initiated in late February or early March and there was a relatively warm spring instead of having to wait until mid-April because of annual cropping tradition (Figure 1). If irrigation was withheld for more than one cutting, total yields were significantly reduced (Figure 2; Ottman et al., 1996). The best cutting to not irrigate is the last cutting, which should take place after a 6 or 7 week rest period in the fall to allow enough time to store energy for the winter and to regrow in the spring. Any cutting that is not irrigated after July probably will not pay to cut and bale because those yields are below 0.5 tons/acre (Orloff and Hansen, 2008). As mentioned before, these regrowth cycles could either be grazed or the harvest interval lengthened to allow for a longer recovery period in which to accumulate root energy. It would likely be best to irrigate for the August harvest and use up the water if it is that limited. Irrigation termination during winter, even on sandier soils, in Arizona did not impact stand density or yield (Ottman et al., 1996). Winter or early spring irrigation in New Mexico is only beneficial only if spring temperatures will be warm. Hence, future prospects should be considered when deciding how to use irrigation water.

When irrigating only three cuttings, the second and third cuttings are critical with either the first or fifth cutting being next (Figure 2). Since alfalfa is more water-use efficient in the earlier cuttings, yields are likely to be higher when the same amount of water is applied. An economic analysis of earlier New Mexico alfalfa irrigation research (Libbin et al., 1993) pointed out that there was no difference in total yield whether the same amount of water was applied early or uniformly spread out across the growing season. Consequently, if water is going to be limited or if the irrigation district regularly runs out of water before season's end, it would likely be more feasible to typically irrigate early in the season and use the water up during periods of greater water use efficiency to produce higher yields. While there may be little difference in yield between summer termination and reduced irrigation across the growing season at the same total water amount, there likely would be a savings on harvest costs due to fewer harvests under a termination regime.

Effect of No Irrigation on Stand

Regarding the effect of no irrigation on stand effects, the non-irrigated study at Tucumcari still had 85% stand after 3 years of no irrigation. Eighty percent stands will have enough plants to be considered monoculture alfalfa by FSA for NAP purposes. In 2010, irrigation water did not become available until mid-June, but the summer irrigation study at Tucumcari was fully irrigated for the rest of the year. There were no differences between treatments for any cutting or for the annual total (Hansen et al., 2007; Orloff and Hansen, 2008). Even the treatment that had not been irrigated since 2005 had yields that were not significantly different from alfalfa that had been fully irrigated throughout its stand life. Consequently, just because the alfalfa is not as productive during periods of reduced irrigation, does not mean that it should be plowed out. Whenever established alfalfa is plowed, the land should be rotated to an annual crop for one year to overcome allelopathy problems. Two years of annual cropping are better. Therefore, when stands are less than 3 or 4 years old, producers should consider the possibility that it may be more economical and less risky to maintain an intact stand producing lower yields for two years in anticipation that irrigation water may become more plentiful than to take the risk of establishing an annual crop with or without irrigation for two years to break down allelopathic compounds before replanting alfalfa. They may also benefit from the NAP for alfalfa if they participate.

SUMMARY

Key management factors for alfalfa during drought or periods of reduced irrigation include variety selection, as well as proper harvest management, weed and insect control, fertility, and irrigation strategies.

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PROCEEDINGS

OF THE

WESTERN NUTRIENT

MANAGEMENT CONFERENCE

Volume 9

MARCH 3-4, 2011
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