1986

G86-826 Irrigating Alfalfa (Revised October 1990)

DeLynn Hay
University of Nebraska-Lincoln, dhay1@unl.edu

G86-826
(Revised October 1990)

NebGuide

Published by Cooperative Extension, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln

Irrigating Alfalfa

Alfalfa has certain water use characteristics. Knowing these and how to monitor soil moisture, apply water, manage irrigation, and schedule water application will help you grow a high quality crop.

DeLynn R. Hay, Extension Specialist--Water Resources & Irrigation

Irrigation makes it possible to grow high quality alfalfa throughout Nebraska on a wide variety of soils. Alfalfa, relatively drought tolerant, will produce yields almost proportional to the amount of water available to the crop. This means that alfalfa will respond favorably to irrigation. Because of its longer growing season, the seasonal water requirement of alfalfa will be higher than for other crops.

Irrigation management must consider characteristics such as water requirements (including total seasonal and daily water use), root system development, and critical stages of growth. In addition, soil characteristics, irrigation system, and available water supply must be considered.

Alfalfa Water Use Characteristics

A water use pattern for alfalfa is shown in *Figure 1*. This water use pattern shows typical daily evapotranspiration (ET) throughout the growing season. Evapotranspiration is the water transpired by the crop plus water evaporating directly from the soil surface. The amount of water used will vary from season to season and for different locations, but will follow the same general pattern. The magnitude of

the water use varies with climatological conditions, but especially depends on temperature (greater with higher temperatures and lower with cooler temperatures).

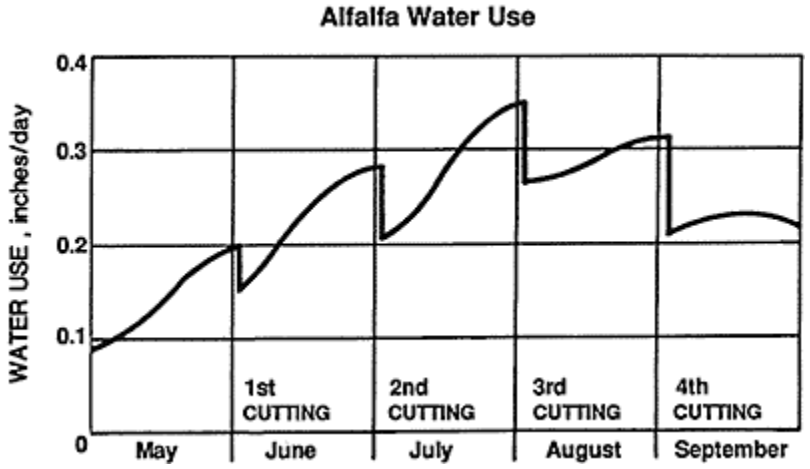

Figure 1. Water use pattern for alfalfa.

Alfalfa begins using water when plant growth starts in the spring. The initial water use is low because growth is slow and temperatures are cool. As the rate of growth and temperature increase, the daily water use increases. The rate rises sharply and reaches a peak at the pre-bud stage. Water use may drop slightly from pre-bud to harvest, but drops sharply when alfalfa is cut. After harvest, alfalfa re-growth begins and the water use cycle begins again. This cycle is repeated for each cutting -- every 30 to 40 days.

Figure 1 illustrates a typical pattern for daily water use. Actual water use varies with changing weather conditions. The primary weather conditions affecting water use are temperature, humidity, wind, and solar radiation. The peak daily water use normally will range from 0.3 to 0.35 inch per day during July and August, but may be as high as 0.5 inch on hot, windy, dry days.

The total seasonal water use will vary with weather conditions, but also is affected by length of growing season, variety, soil fertility, irrigation and harvest management, water availability, and the interactions of these factors. The Soil Conservation Service's Nebraska Irrigation Guide reports average annual alfalfa water use as 30.6 inches at Scottsbluff, 33.1 inches at North Platte and 38.0 inches at York.

During the peak period, July and August, the alfalfa crop will use about 5 to 6 inches of water for each ton of field-dry hay produced. If yields of 1.5 tons per acre per cutting are expected, 7.5 to 9.0 inches of water would be required for the third and fourth cuttings. If all of this water must be supplied to the crop by irrigation, 10 to 12 inches would need to be applied (assumes an application efficiency of 75 percent) to meet the net requirement of 7.5 to 9.0 inches. In most cases, some of the water requirement will be supplied by precipitation and moisture stored in the soil, so the net irrigation requirement for the third or fourth cutting will typically be 6 to 7 inches. The corresponding gross irrigation requirement will be 8 to 9.5 inches (75 percent irrigation system application efficiency).

Other Crop Characteristics Important to Irrigation Management

The active roots of the alfalfa plant can penetrate 8 to 12 feet in deep, well-drained soils. irrigationd alfalfa will obtain 75 to 90 percent of its moisture from the upper four feet of soil. During the growing season, irrigation normally should not supply water any deeper than four feet in the soil profile.

Irrigation and precipitation in the fall or early spring can supply water to the deeper portions of the soil profile for use during the growing season. The water in the lower portion of the root zone is especially important if the water demand of the crop cannot be totally supplied by the irrigation system during peak water use periods.

A clay pan or other restrictive soil layers can limit the root zone depth. Shallow root zones require smaller and more frequent irrigations.

Alfalfa does not have a stage of growth that is extremely critical or less sensitive to moisture stress. If moisture is not available, the plant will stop growing and go dormant. When moisture becomes available, growth will resume. However, lack of moisture will reduce yield. In Nebraska, precipitation and stored soil moisture will normally be adequate for the first cutting. Thus, when the irrigation water supply is limited, irrigation will probably be most beneficial just before the second cutting and during the third and fourth cutting growth periods.

Although alfalfa responds well to irrigation, it can be damaged by too much water. Alfalfa is susceptible to damage from over-irrigation, ponding of water, and high water tables, especially on fine-textured soils with low permeability. Crop damage results from poor aeration and diseases such as the crown and root rots. Damage will be more extensive during periods of high temperatures. In general, the alfalfa plant should not be submerged in water for more than 24 to 48 hours to prevent reduced growth and stand loss.

Subirrigation from high water tables can effectively meet the water requirements of alfalfa. However, alfalfa cannot tolerate "wet feet." In general, serious damage may occur when water levels are at depths of three to four feet or less.

Applying Water

Alfalfa responds well to water application regardless of the type of irrigation system used. With surface systems, it is important to have good land preparation before seeding. The topography and degree of water control desired will determine the extent of land preparation required. Once the stand is established, no further preparation can be done. The most common surface systems used are border strips and furrows or corrugations, although basin and wild flooding may be used.

Border strip irrigation is used on deep soils with gentle slopes. The field is separated into strips by small dikes that restrict the lateral surface movement of water. Extensive land grading and preparation normally are required to distribute water uniformly. The width of the strips depends upon the slope of the land, the size of the water supply, soil intake, and the size of the equipment used.

Basin flooding is similar to border strips except that the dikes enclose a completely level basin. The water is applied quickly and ponded until it infiltrates the soil. If excessive rainfall occurs, provisions must be made to provide drainage from the basins so crop damage does not take place.

Furrow irrigation can be effective for alfalfa if adequate slope, proper stream sizes, and proper lengths of run are used. Furrow spacings normally will vary from 30 to 60 inches. Spacings greater than 60 inches probably will not provide adequate lateral movement of water in the soil. Furrow spacings should be matched to the wheel spacing of harvest equipment. The furrow size should be adequate to carry the recommended furrow stream, but not so large that considerable growth is left in the furrow at harvest time. Small furrows or corrugations spaced 15 to 30 inches apart to direct the water across the field also may be used. With the small furrows, the length of run must be shorter and furrow stream size will be

smaller. The Soil Conservation Service can provide design guidelines for surface irrigation systems.

Most types of sprinkler systems can be used effectively. The center pivot system is the most common. Towline, side-roll, traveling gun, solid set, and other sprinkler systems can also be used. Sprinkler systems capable of frequent light irrigations can be used to establish an alfalfa stand. When properly designed, sprinkler systems can be adapted to most soil and topographic conditions.

Irrigation Management

Irrigation management includes deciding when and how much to irrigation. The decision must be based on the available irrigation water supply, the available water holding capacity and intake rate of the soil, and the water needs of the alfalfa. The management objective normally will be to meet the crop water needs to provide for optimum plant growth. The success in meeting crop needs will depend upon the size of the available water supply. The timing of harvest and other time factors also must be considered. irrigationd alfalfa management is more flexible because of the rooting depth and response to water application. Criteria to help determine when to irrigation include crop appearance, soil moisture monitoring, and water use prediction based on climatic data.

Crop Appearance

The appearance of alfalfa can indicate soil moisture status. When adequate moisture is available, alfalfa usually will be light green. As moisture stress develops, the color darkens. When the plant has turned dark green, apply water before wilting occurs, otherwise yield and quality will be reduced. Wilting generally will occur when about 25 to 30 percent of the available water capacity remains in the root zone.

Monitoring Soil Moisture

Soil moisture can be monitored to determine when to irrigation, and how much water to apply. Several methods can be used to monitor soil moisture. A soil probe can be used to obtain a sample at a given depth, and the "feel and visual" method can be used to estimate the moisture level in the soil (see NebGuide G84-690). Gypsum resistance blocks can be used on medium and fine-textured soils (See EC89-723). Tensiometers are used on sandy soils (See EC89-724). Other soil moisture monitoring methods also may be used, but the soil probe is probably the most useful tool.

Alfalfa will maintain optimum growth when the soil moisture ranges from 35 to 85 percent of that available for plant growth. As long as the moisture remains in this range, there will be little difference in yield and water use. For optimum production, the soil moisture balance in the root zone should not drop below 35 percent of the available water capacity. Start irrigation in time to prevent the soil moisture in any part of the field from dropping below 35 percent of the available water holding capacity. From a practical standpoint, and especially for coarse textured (sandy) soils, start irrigation when 50 percent of the available water capacity has been used.

Proportion of Growth

Knowing the crop water requirements, soil characteristics, and proportion of crop growth that has occurred, an experienced irrigator can estimate irrigation needs. Weather conditions and precipitation also must be considered.

For example, if a yield of one ton per acre is expected, about six inches of water will be required for the

cutting. To estimate how much water is needed to refill the profile at any given time, estimate the proportion of growth that has been made. If 50 percent of the growth has occurred, 3.0 inches of water would have been consumed (0.50 × 6.0). The net application amount would be 3.0 inches which would require a gross application of 4.3 inches if the system is 70 percent efficient (3.0 in. ÷ 0.70).

Calendar Schedule

To determine a calendar schedule, use an estimated water use rate and soil moisture holding capacity. For example, if the average water use rate is 0.35 inch per day and the available water capacity is 1.75 inches per foot, the following schedule could be developed.

Root zone = 3.0 ft.
Available water capacity = 3.0 ft. × 1.75 in./ft. = 5.25 in.
Minimum allowable balance = 35 percent
Available water at minimum allowable balance = .35 × 5.25 = 1.84 in.
Usable water = 5.25 in. - 1.84 in. = 3.41 in.
System application efficiency = 70 percent
Gross irrigation application = 3.41 in. ÷ 0.70 = 4.87 in.
Irrigation frequency = 3.41 in. ÷ 0.35 in./day = 9.7 days

In this example, irrigations of 4.9 inches would be applied every 10 days.

Weather conditions, irrigation system capacity, and other factors must not be overlooked when using either the proportion of growth or calendar schedule. Without consideration of all the factors involved, it will be easy to over or under irrigation.

Crop Water Use Information

Daily weather data can be used to estimate crop water use. A series of automated weather stations across Nebraska now makes the weather data widely available. The estimated crop water use is calculated using data from the automated weather stations. The weather data and estimated crop water use are available from a computer bulletin board (WEATHER) operated by the High Plains Regional Climate Center at the UNL Department of Agricultural Meteorology. The water use information is also available from some radio stations, newspapers, and telephone hotlines.

The crop water use estimates are input for calculating the current soil moisture status of a given field. The procedure used is sometimes called "checkbook irrigation scheduling" and is described in NebGuide *G85-753, Irrigation Scheduling Using Crop Water Use Data*. The soil acts as a "bank" or reservoir to store water for crop use. Rain and irrigation are deposits to the bank and the crop water use is a withdrawal. Like a checking account, a weekly (or any other interval) balance of these deposits and withdrawals will give the amount of water remaining in the root zone. Schedule irrigations to assure that the soil water balance does not drop below some minimum balance. Do not use a minimum allowable balance lower than 35 percent for alfalfa on fine-textured soils and 50 percent on coarse-textured soils.

The calculated soil water balance can be checked periodically by using some type of soil moisture monitoring. Measuring the irrigation water applied to a field will improve the accuracy of the soil water balance calculation.

Other Considerations

A major consideration for irrigation timing is interference with harvest. irrigation as close to harvest as possible to meet the peak needs of the crop and have adequate moisture available to start re-growth. The surface of the soil should have enough time to dry to prevent excess soil compaction during harvest. If the surface is too wet at harvest, the soil will be compacted by the harvesting equipment, seriously reducing the soil intake rate for future applications of water.

Although surface irrigation may be easiest just after cutting, the alfalfa plant is most vulnerable to excess water at this time. Irrigating immediately after harvest also may stimulate weed growth. As a general rule, complete irrigation five days before cutting and do not start again until five days after cutting. The full 10-day interval will not be possible on soils with low available water capacity or when the irrigation system capacity is limited.

Fall irrigation can be an important management tool on deep, medium textured soils in the dryer areas of the state. Fall irrigation provides good growing conditions for winter dormancy and helps the plant build its reserves in the root system, and gives vigorous spring regrowth. The deeper portion of the soil profile can be refilled in this off-season period because peak water use is not placing a demand on the system capacity. The moisture placed in the deeper portion of the profile will be available during the peak water use period. When water is applied in the fall, avoid excessive applications which cause water movement below the root zone or ponding which causes crop loss.

Because of its deep, well-developed root system, alfalfa can allow the irrigator to use rainfall efficiently. To maintain the best growing conditions and receive the greatest benefit from rainfall, irrigation applications should not exceed four inches except for a fall or spring irrigation on deep medium-textured soils. The off-season irrigation may be as large as six inches to ensure that moisture is available in the deeper part of the root zone (below four feet). In eastern Nebraska it is possible to more effectively utilize rainfall if the soil profile is not completely refilled each irrigation. This leaves moisture holding capacity in the soil to store rain occurring immediately after irrigation.

For surface irrigation systems using applications of about four inches, two irrigations per cutting normally will be required. Start the first application about five days after cutting and finish the second about five days before cutting. This type of schedule must be adjusted to reflect soil moisture status, crop needs, and system capacity.

For sprinkler systems, the size of application will be smaller and range from 1.0 to 1.5 inch for sandy soils and 1.5 to 3.0 inches for medium-textured soils. Because of the lower application amounts, the irrigation frequency likely will range from three to seven days. Because of system capacity, most sprinkler systems probably will need to operate almost continuously, except at harvest, during the peak water use period to meet the needs of the alfalfa crop.

Summary

Alfalfa can be grown and irrigationd on a variety of soils, but the deep, uniform, well-drained, medium-textured soils are easiest to manage. Most irrigation systems can be used on alfalfa if they are designed properly for the site.

Seasonal water use in Nebraska ranges from 30 to 38 inches, depending on location and weather conditions (including precipitation). The peak daily water use rate of alfalfa will normally range from 0.30 to 0.35 inches. The water requirement is approximately six inches for each ton of hay produced.

For optimum growth, maintain soil moisture in the root zone at 35 to 85 percent of the available

moisture holding capacity. Schedule irrigations so the soil is not excessively wet at harvest. Monitor soil moisture status and combine with crop water needs, system capacity, and soil available water capacity for effective irrigation management.

Excess water causes diseases, reduced growth rate, and loss of stand.

File G826 under: Range AND Forage Resources
B-27, Forages
Revised October 1990; 1,000 printed.

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Elbert C. Dickey, Director of Cooperative Extension, University of Nebraska, Institute of Agriculture and Natural Resources.