IRRIGATION MANAGEMENT IN ALFALFA

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Since most alfalfa in southern Idaho is grown under irrigation, irrigation management is an important aspect of alfalfa crop management. Good irrigation management is essential if high yields of quality alfalfa are to be achieved. Good alfalfa management is achieved by water application based on knowledge of crop water requirements and water storage in the soil.

Soil-Water Relationships

Evaporatranspiration (ET) is the sum of transpiration and water evaporated from the soil and exterior portions of the plant. Consumptive use is ET plus water retained in plant tissue. Since the maximum amount of water in the plant is less than 1% of total water evaporated during the growing season, CU is identical with ET for practical purposes (Pair, 1975). Studies on ET in alfalfa have shown that yield is a function of ET and thus a deficit in ET results in a proportional yield deficit. This relationship occurs because ET correlates with CO_2 exchange through the stomates (Guitjens 1990). Wright (1988) reported the results of several years of investigation on ET of irrigated alfalfa in southcentral Idaho. He found that daily ET averaged 8 mm (0.31 in.) per day during peak ET periods but sometimes went as high as 10 mm (0.39 in.) per day. In the April through October growing season ET averaged 1022 mm (40.23 in.). These results indicated that actual ET of well-irrigated alfalfa may be substantially higher than previously used estimates. According to Shewmaker et al., (   ), alfalfa response to irrigation is linear and it takes 5 inches of water per ton of alfalfa at Kimberly. Hay harvested at 12% moisture removes 240 lb water/ton of hay. However, this quantity is very small compared to the amount lost as ET. Stress to the alfalfa plant occurs when available soil moisture drops below 50%. Alfalfa plants have the ability to go into a drought-induced dormancy and the plants should survive until they receive water if they have adequate carbohydrate reserves going into the drought period.

Understanding the principles of water storage in the soil is critical to irrigation management. When water is applied to a field pores between soil particles are filled and water percolates downward in the soil profile until a point (field capacity) is reached where water downward movement ceases and the remaining soil water is held as a film on soil particles. Thus, the soil profile is a storage reservoir from which plants extract water. Water holding capacity (WHC) is related to texture with coarse textured soils having the lowest WHC and fine textured soils having the highest WHC. Water storage capacity available to a crop is determined by multiplying the water holding capacity of the soil by the rooting depth of the crop. The effective rooting depth of alfalfa is four feet even though alfalfa roots can penetrate as deep as 12 feet if not restricted by impenetrable layers. This is true because at least 70% of the water used by alfalfa is taken up in the top 4' of the soil profile. For alfalfa, studies have shown that soil must be maintained at or above 50% of available water holding capacity. Thus, for alfalfa the allowable depletion is 50% of the available water in the root zone.

Alfalfa Irrigation

Alfalfa differs from most other irrigated crops in that it has a deep root zone that is able to utilize water from the entire soil profile in most southern Idaho sols. Although alfalfa extracts most of its water from the upper four feet of soil, its roots may extend as deep as 12 feet. Water utilization from the lower part of the soil profile is particularly important in years where water supplies are limited. Early irrigation to fill the root zone will produce healthy roots in the lower root zone to take full advantage of the soils WHC and the plants long root system. In normal years this deep moisture supports alfalfa growth when irrigation is stopped for harvest and in drought years it ameliorates the yield-reducing effects of a deficit ET.

Irrigation Schedules

Irrigation scheduling can be accomplished through two methods: The soil moisture method and the water budget method. Both methods can be used concurrently and it is a common practice to schedule irrigation based on the water budget method but verify based on soil moisture monitoring.

Irrigation scheduling by the water budget method involves monitoring water additions (irrigation and rainfall) and losses from evapotranspiration and inefficiencies in the irrigation system. Evapotranspiration is the sum of water lost by evaporation from the soil surface and transpiration through the plant's stomata. Evapotranspiration values are available from local newspapers or the U.S. Bureau of Reclamation website (http://www.pn.usbr.gov/agrimet). Irrigation is scheduled by doing the following procedure: 1) Obtain an estimate of alfalfa water use for the station closest to your location, 2) Add daily water use to running total of water use to date, 3) Subtract water additions from irrigation and rainfall, 4) Schedule irrigation to replace accumulated water use by the crop.

In the soil moisture method, soil moisture content is measured and irrigation is done before the allowable depletion has been reached. Several methods are available including the feel method, tensiometers, gypsum blocks, granular matrix sensors and neutron probe. It is common practice to graph soil moisture readings with soil moisture on the Y axis and time on the X axis to produce a visual image of how fast the soil is drying. Because alfalfa is a deep rooted crop, it is important to measure soil moisture at more than one depth. It is an accepted practice to schedule irrigation based on an 18" reading but also monitor moisture at 36" to ascertain whether the crop is utilizing deep water (Orloff et al. 1995).

Recent studies at the Parma Research and Extension Center have demonstrated the potential for substantial improvements in alfalfa irrigation management. Water loss in furrow irrigated plots was reduced from 30-35% to 20-25% by careful monitoring of water in the furrows. Evaporational loss was reduced by better synchronization of harvest and irrigation. Studies showed that newly wetted bare ground loses as much water as the canopy of a newly irrigated alfalfa corp. High evaporative loss occurs until the soil surface dries or the crop canopy develops. At Parma, a 3-week irrigation cycle was used in which irrigation was avoided for 2 weeks before cutting and 1 week after cutting. A dry soil surface at cutting hastens crop drying and reduces soil compaction and pest problems (diseases, insects and weeds) (Romanko, 1994).

Recent drought years have demonstrated the importance of developing irrigation management methods to deal with low supplies of irrigation water. Crop management situations include 1) water is available for the entire growing season but in reduced quantity, 2) water will be shut off entirely at some point in the growing seasons. In the former situations, the grower should be especially careful to fill up the entire soil profile early in the season to take full advantage of the alfalfa plant's deep root system. Strategies for income optimization with a limited water supply include 1) irrigating for maximum yield and terminating irrigation once the available water supply has been used and 2) underirrigating for all growth cycles, reducing the yield of each harvest but producing hay throughout the growing season. In some cases, it may be possible to irrigate fully during the most sensitive stages of alfalfa growth and use deficit irrigation during less sensitive growth stages. For example, initial regrowth following cutting is a sensitive period that responds well to a full water supply. In ears when water must be cut off early in the season, such as the power buy back, the grower must manage to minimize long-term damage to the alfalfa stand (Guitjens, 1990). This can be done by allowing the last cut to mature and dry so that the plants will go into dormancy (Shewmaker, et. al.,)

Improved irrigation management in alfalfa is beneficial because it optimizes yield while minimizes power cost, nutrient leaching and other deleterious effects of excess water.

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