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Yield and Water Use of Alfalfa

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Alfalfa hay was harvested on approximately one million acres in Kansas in each of 1979 and 1980. In 1979 the average yield was 3.50 tons/acre; in 1980, 2.85 tons/acre. Because alfalfa production is so important to Kansas agriculture, it is important to know more about its water requirements.

This report is of a study on evapotranspiration rates, soil water depletion patterns, and hay yields of alfalfa grown under irrigated and nonirrigated conditions in 1980.

We realize that different soils, different weather conditions, and different irrigation levels will influence all of the actual values discussed in this report. However, the trends and patterns should be of interest and use to an alfalfa grower.

The alfalfa (*Medicago sativa* L. 'Cody') grew in basin plots (each plot 30 feet by 30 feet) on a Eudora silt loam soil near Manhattan. The Eudora soil series consists of deep, nearly level soils that formed in coarse, silty alluvium on high flood plains or low terraces along rivers. Eudora soils are well drained and are moderately permeable.

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The alfalfa was mowed on 3 June, 8 July, 7 August, and 8 September and was irrigated on 13 June, 14 July, and 11 August with 10 cm (4 inches) water at each irrigation. The irrigation water and stored soil water were the main sources of water for the plants in 1980 because the summer was one of the hottest and driest on record. Average temperatures for June, July, and August were 78.4, 87.8, and 83.9°F, respectively, which were 4.1, 8.7, and 5.5°F higher than average. Rainfall during June, July, and August was 2.81, 1.20, and 2.94 inches, respectively, which was 3.03, 3.18, and 0.66 inches below normal. During the growing season, soil water content was determined to a depth of 312 cm (10 feet) using a neutron attenuation probe. Evapotranspiration rates were calculated as the total of profile water depletion, rainfall, and irrigation in a given time period divided by the number of days.

Figure 1 presents the evapotranspiration rate of irrigated and nonirrigated alfalfa. The highest evapotranspiration rate (13 mm/day or 0.5 inches/day) was during 21 June to 1 July (maximum temperature was 109°F on two dates during that interval). Decreasing evapotranspiration rates during the summer in the nonirrigated plots were primarily due to a decrease in water stored in the soil profile. We assumed all water was lost from the soil profile by evapotranspiration and none by drainage. This assumption appears valid because we measured soil water to the 10-foot soil depth and because it was an extremely dry summer.

Figure 2 presents soil water content at the different measurement depths during time intervals following the three irrigations (23 June—10 days after first irrigation; 7 July—3 days after second irrigation; and 15 August—4 days after third irrigation). Rainfall amounts for the three measurement intervals were: 23 June—1 July, no rainfall; 17—28 July, 0.63 inches; and 15—29 August, 0.35 inches.

The irrigation water seemed to penetrate to about the 120-cm (4-foot) depth, based upon changes in soil water content from before to after irrigation. Roots appeared to extract water to the 230-cm (7.5 foot) depth, based upon water depletion within the three measurement intervals listed. Water content was nearly constant with time below the 230-cm depth for both irrigated and nonirrigated conditions (Fig. 2). This indicated that roots were not active below 230 cm, assuming that water was not entering to replace any that might have been taken up by roots.

Figure 3 shows the dry-weight yield of hay in metric tons/ha (U.S. tons/acre = metric tons/ha multiplied by 0.446) as related to evapotranspiration

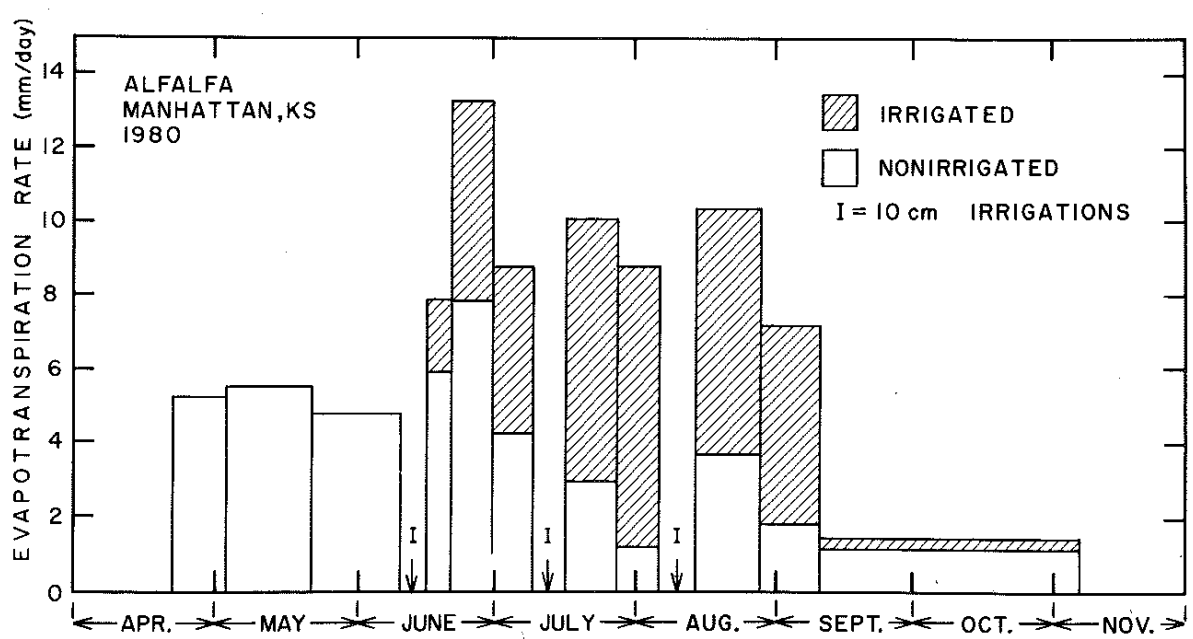

Figure 1. Evapotranspiration rate of irrigated and nonirrigated alfalfa.

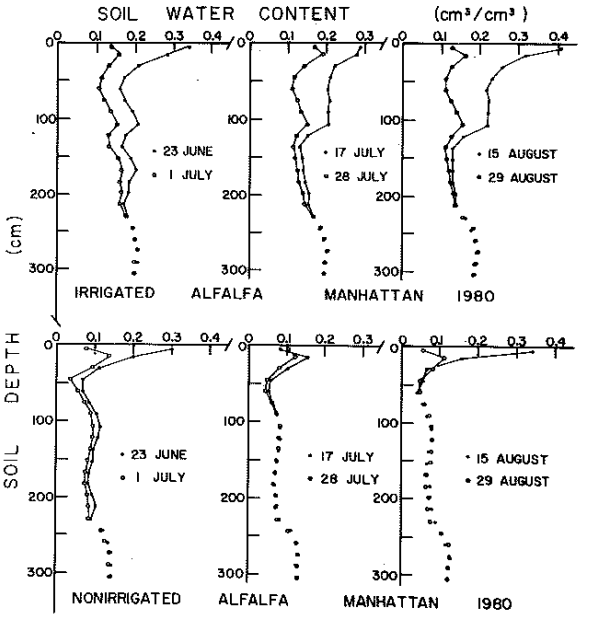

Figure 2. Soil water content at different depths for irrigated and nonirrigated alfalfa on six dates in 1980.

amount (cm/cutting). To convert the dry-weight values to weights at 15% moisture content, multiply by 1.18. Hay yield increased as evapotranspiration amount increased, up to about 30 cm/cutting (12 inches/cutting).

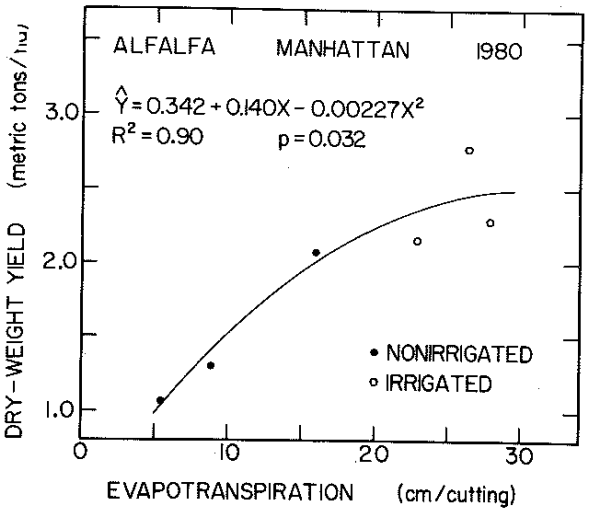

Figure 3. Dry-weight yield of alfalfa as a function of evapotranspiration amount.

SUMMARY

The results showed the following for irrigated alfalfa grown on Eudora silt loam soil near Manhattan during the dry, hot summer of 1980:

1. Irrigation water infiltrated to a depth of abo 4 feet.
2. Roots extracted water to a depth of about 8 feet (when water was available).
3. The maximum hay yield was obtained at a water use value of approximately 12 inches per cutting.

Contribution 82-347-S, Department of Agronomy.

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