ALFALFA PRODUCTION WITH DIFFERENT QUANTITIES OF WATER IN THE CENTRAL SAN JOAQUIN VALLEY

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Irrigation water management is a key component to total management of crop production systems in the irrigated west. There are 900,000 acres of alfalfa with a combined hay/forage use in California and the average water addition is about 4.7 feet. Extremes of up to 13 feet of applied water have been observed in the lower desert region; a range in water addition of from 4 to 8 feet is observed in the Tulare Basin that is typical of about 60 percent of the state's acreage.

It appears that instances of both excessive water use and deficit irrigation for alfalfa can be found, but quantitative information is lacking that defines water-yield and water-hay/forage quality responses. This study was established to define water-yield/quality production functions for contrasting dormancy characteristic cultivars in the Central San Joaquin Valley.

METHODS

Plots were established by seeding three cultivars; CUF 101 (very nondormant), Moapa 69 (nondormant), and WL 318 (semidormant), on September 26, 1984 at a rate of 30 pounds of seed per acre. A preemergence herbicide, Balan, was applied at the label rate on September 20. The seeded area was lightly sprinkled uniformly several times at two to three day intervals to insure uniform germination and stand establishment.

The three cultivars were established in a randomized complete block field plot design with three replications; cultivar whole-plots were 28 feet x 90 feet and the entire experimental area measured 300 feet in length and was 90 feet wide. The irrigation variable was introduced by installing a single sprinkler line directly in the north-south centerline of the 300 feet area length; border plots of 24 feet were accommodated at each of the north and south ends of the plot area.

Rainbird 30 series sprinklers, equipped with a single 11/64 inch nozzle, were installed at 15 feet intervals along the sprinkler line. This relatively close spacing resulted in a uniform water application parallel to the length of the line and uniform reductions with increased distance away from the line source. Operational pressure of 50 pounds per square inch, provided by a 10 horsepower gasoline engine and pump assembly, resulted in a radius of application of 45 feet. The 45 feet on either side of the sprinkler line was divided into eight equal increments of 5.6 feet that served as water application variable subplots of each cultivar wholeplot. Therefore, there were 144 plots, each 5.6 ft. x 28 ft., comprising the entire experiment.

A total of 14 irrigations were made during the year to replace water evapotranspired totally for plots adjacent to the sprinkler line. Irrigations were scheduled when approximately 2.5 to 3 inches of water were depleted from these plots; therefore, irrigations were required at 8 to 12 day intervals during the highest evaporative demand times. Running all the sprinklers at one time resulted in an application rate that exceeded the static infiltration rate for the soil. Because of this, a selenoid value assembly was placed in the riser for each sprinkler and coupled to a sequencer. This allowed operation of one-third of the sprinklers at a time and reduced the application rate to allow continuous operation of the system without ponding or runoff. Applied water was measured with a series of 16 catchment cans, placed in the border between cultivar plots, but in line with the center of each plot, running perpendicular to the sprinkler line. Each of the three cultivar blocks was monitored this way.

Soil of the experimental site is a Hanford sandy loam, silty substratum. The average sand, silt, and clay content percentages and standard deviations through a seven foot profile depth are, respectively, 50.6 ($\pm$ 3.2), 35.9 ($\pm$ 4.2), and 13.5 (1.2). Soil bulk density averages 1.46 g cm^{-3} for the profile and is quite uniform; the standard deviation being only 0.04 g cm^{-3} for one foot depth increments over the seven foot depth.

Harvesting was accomplished with a hand operated Kinco, KMG-38, sickle mower. Fresh weigh from the 38 inch wide x 24.8 ft. harvested area was obtained and samples were collected for moisture determination and quality analysis. Seven harvests were done; the first on March 20 and the last on October 7.

RESULTS

An objective of the single sprinkler line source method used in this study is to have a near linear decline of water amounts with increased distance away from the line source. Figure 1 shows that this objective was reasonably well achieved. Water amounts closest to the line should slightly exceed the amount required to achieve maximum productivity in order to characterize the full water response range. A prevailing north westerly wind direction at the study site is shown by a slight shift from west to east in the distribution pattern. Total irrigation and rainfall varied from 18.3 inches to 51.2 inches.

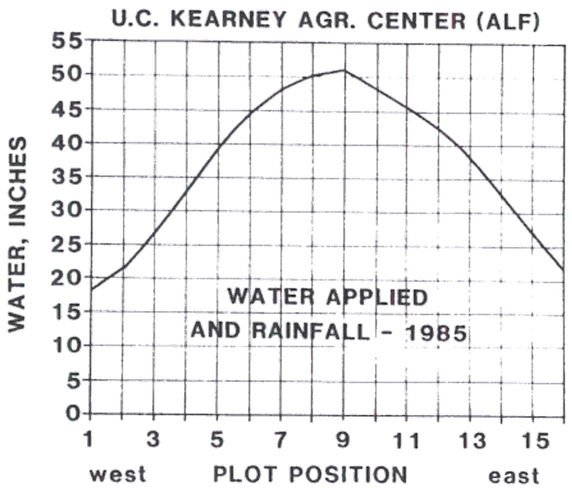

Figure 1. Total irrigation and rainfall amounts from establishment through the final harvest of 1985.

Total hay yields, at 12 percent moisture, for the three cultivars are presented in Figures 2, 3, and 4. The yield response for all cultivars was linear with increased water up to approximately 44 inches. Water added above that requred to achieve maximum yield was associated with near stable yields close to the maximum observed.

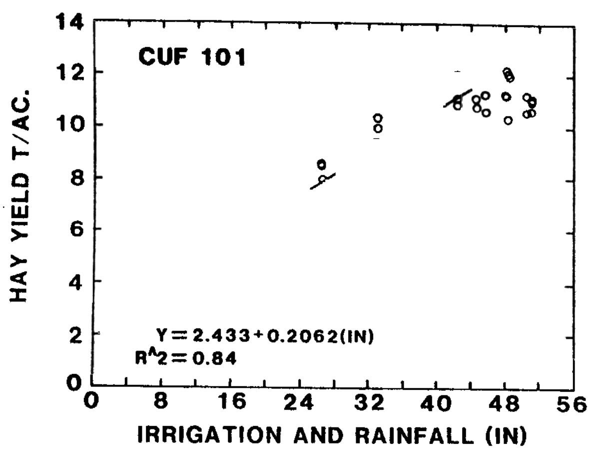

Figure 2. Total hay yield of CUF 101, at 12 percent moisture, for varying water quantities.

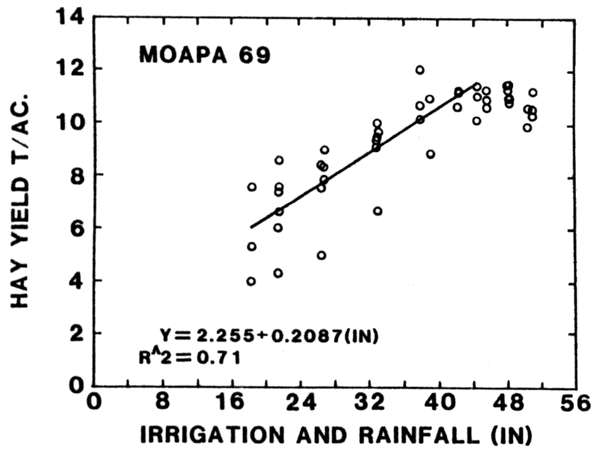

Figure 3. Total hay yield of Moapa 69, at 12 percent moisture, for varying water quantities.

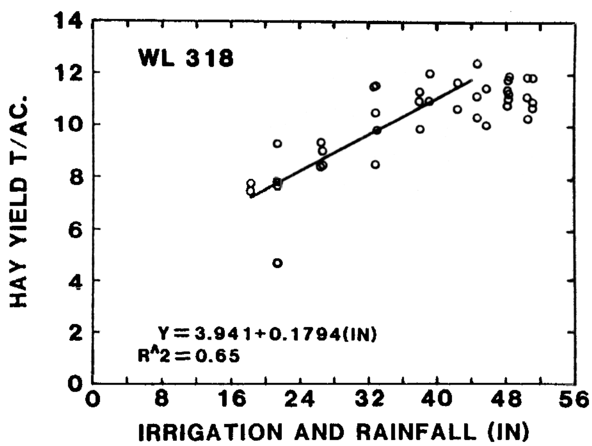

Figure 4. Total hay yield of WL 318, at 12 percent moisture, for varying water quantities.

Because of the relatively good water retention properties of this Hanford soil and limited impedance to root growth and extension through an eight foot depth, no appreciable yield differences to varying water amounts was observed through the first two harvest dates. From the third harvest through the seventh, progressively severe drought conditions were observed for water deficit plots as the soil-stored water was depleted.

The water status of all cultivars was monitored on several occasions by determining the xylem water potential with a pressure chamber technique and canopy temperature with a hand-held remote infrared thermometer. Results of midday measurements on August 23, 1985 are presented in Figures 5 and 6. Nonstressed plants had a xylem water potential of about -8 bars while the water potential of severely stressed plots was as low as -21 bars. Canopy temperature of nonstressed plots was about 28°C while severely stressed plots was as high as 43°C. Both techniques offer a potential for providing a reliable plant-based measure of water status.

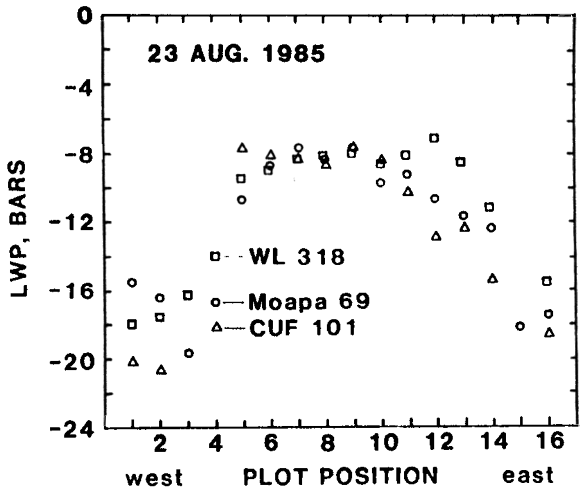

Figure 5. Xylem water potential (LWP) on August 23, 1985 for plots subjected to progressively severe water deficit conditions. The irrigation line is between plot positions 8 and 9.

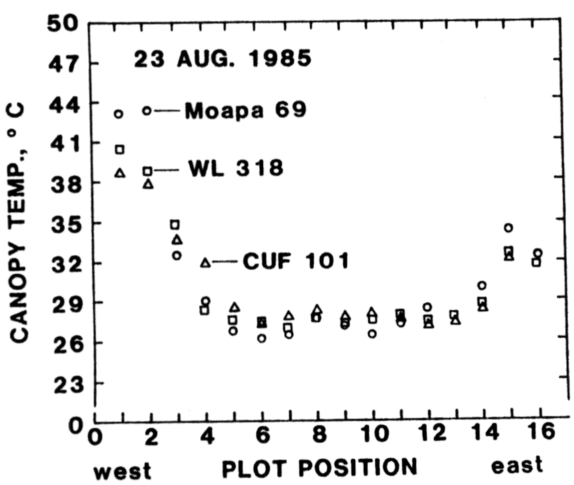

Figure 6. Canopy temperatures from infrared thermometry for plants subjected to increasing water deficit conditions. The irrigation line is between plot positions 8 and 9.