Influence of Temperature and Harvest Management on Growth, Level of Carbohydrates in the Roots, and Survival of Alfalfa (Medicago sativa L.)

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GROWTH of alfalfa in the southwestern United States is considerably retarded during July and August. This decrease in growth is often referred to as a "summer slump." Although high temperatures are commonly blamed for this decreased growth, acceptable proof is lacking.

Cutting practices have been studied, for the most part, as they relate to winter survival and/or low-temperature injury. According to Wilsie (17), high temperatures may be just as limiting a factor in the production of crops as low temperatures. Levitt (12) has stated that it is well recognized that plant growth stops at high temperatures that are not immediately fatal. Meyer and Anderson (13) have stated that the optimum temperature for respiration in most plants is higher than for photosynthesis, and the accumulation of reserve food material in any plant is reduced by relatively high temperatures.

Leaf discs from plants classified as heat-tolerant and heat-susceptible by West and Prine (16) required similarly at 86° F., but leaf discs from heat-susceptible plants respired 36% faster at 104° F. than did those from heat-tolerant plants. They hypothesized that alfalfa persisted poorly in Florida because night temperatures were comparatively high during the summer months. West and Prine also found that the level of carbohydrates in the roots of Hairy Peruvian alfalfa, harvested at 1/10-bloom, dropped to lower levels with each successive harvest, and the time required for carbohydrate reserves to begin to build up lengthened as the season progressed.

Numerous experiments (2, 4, 8, 11, 14) have shown that alfalfa usually responds adversely when cut too frequently. Other research workers (3, 7, 10, 15) have reported that harvest management is reflected in subsequent years. Nondormant alfalfas make some growth throughout the year in the Southwest. A knowledge of how storage and utilization of carbohydrates are influenced by harvest management, temperature, and the interaction of these factors may serve to predict managerial practices conducive to survival of alfalfa under conditions of prolonged high temperatures.

MATERIALS AND METHODS

The field work was conducted at the University of Arizona Campbell Avenue Farm, Tucson, Arizona. All data reported were obtained during 1960, 1961, and 1962. 'Moapa,' a nondormant alfalfa variety, and 'Lahontan,' a variety intermediate in winter hardness and dormancy, were seeded at a rate of 20 pounds per acre with a Cultipacker seeder October 7, 1960. Eighty-eight pounds of phosphorus (P) per acre, as triple super-phosphate, had been incorporated into the soil prior to seeding. The experiment was designed as a split-plot with varieties as whole-plots and cutting intervals as subplots. Four replications were used. The cutting schedules were randomized within each whole-plot, but the varieties were not randomized since the experiment was conducted with border irrigation and plants of Moapa grew throughout the winter.

Plots were irrigated each time the moisture tension of the soil reached 0.45 to 0.65 atmosphere at a depth of 12 inches. Insects were controlled by dusting periodically, and weeds were controlled on the border ridges.

Subplot treatments consisted of 3 harvest schedules: cutting at the bud (50% or more of stems with floral buds prominent), at 1/10-bloom (10% of stems displaying flowers), and at full-bloom (95% or more of stems displaying flowers) stages of growth. These management schedules were followed except on May 6, 1961, when all plots were initially harvested, January 19, 1962, when all Moapa plots were harvested, and March 30, 1962, when all plots of both varieties were clipped. Forage yields were determined by cutting and weighing green forage from 3- by 50-foot strips, and a subsample of approximately 500 g. from each green sample was dried at 150° F. to determine dry weights.

The number of plants within a 12- by 24-inch frame was recorded soon after establishment from 50 locations in each 24- by 50-foot subplot. Stand depletion was calculated by comparing original counts with the number of plants dug from one of these same 12- by 24-inch areas on each harvest date.

After the roots and crowns of plants dug at each harvest had been washed, four plants were selected at random from each sample and kept refrigerated until they could be examined for disease damage. The remaining plants were clipped to leave a 1/2-inch stubble length, and tap roots were clipped 6 inches below the base of the crown. The number of live stems and crown buds that were green in color or at least 0.5 cm. in length, and the diameter of the crown at its widest point, were recorded for each plant. Roots and crowns were then separated, frozen with dry ice, dried at 150° F., in a forced-air-drier for 24 hours, further dried at 176° F. in a controlled temperature oven for 24 hours, weighed, and ground in a Wiley mill to pass through a 0.05-mm. sieve. Root samples were also collected from each subplot at 3-