Monthly Variation in the Chemical Composition of Desert Saltbush[1]

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Highlight

An intensive study was undertaken on a southern California range to elucidate the nutritive value of *Atriplex polycarpa* (Torr.) S. Wats. The investigation was designed to show variations in forage values throughout the year and to denote, if any, the correlations between nutritive qualities and the environmental conditions. Forage samples were analyzed for protein, fat, calcium, phosphorus, fiber, total ash, and nitrogen free extract; total digestible nutrients were calculated from digestion coefficients. Although the results showed significant variations in forage value throughout the year, the nutritional requirements of a grazing animal were generally satisfied. Desert saltbush can therefore serve as a dietary supplement and provide important nutritional components such as protein, calcium, phosphorus, and carotenoids when these components are less than adequate in the other available forage.

Desert saltbush (*Atriplex polycarpa* (Torr.) S. Wats.) is an evergreen shrub native to the deserts of southwestern United States. As a perennial it is often the only source of feed available when annual plants are dormant. When dry annual forage is plentiful, cattle graze the dry feed and supplement their diet by browsing desert saltbush. Range forage is sometimes less than adequate in essential nutrients and chemical analysis is necessary to elucidate such deficiencies. As management is intensified, an understanding of forage quality becomes increasingly important.

The chemical composition of a broad class of forage species has been reported by numerous investigators (Cook et al., 1959; Daniel, 1934; Hart et al., 1932; Stoddart, 1941; Weir and Torell, 1959). Conspicuous changes in the chemical composition of grasses and forbs occur with their development (Fraps and Fudge, 1940; Gordon and Sampson, 1939; Patton and Gieseker, 1942; Watkins, 1943). Although the calcium content generally remains relatively constant, protein and phosphorus often decrease with plant maturity. Fiber and nitrogen-free-extract, on the other hand, frequently increase. Other investigators (Cook and Harris, 1950) reported little change in the nutritive value of some desert shrubs through the grazing season. However, in a later study Cook et al., (1959) found that the nutritive value of the animals' diet changed through the year because, with continued grazing, the portion of the plant remaining for further consumption was continually changing. The present investigation was undertaken in an attempt to characterize the forage value of desert saltbush during all seasons of the year and to determine, if any, the correlation of forage values with environmental conditions.

Materials and Methods

Samples were collected from representative plants at a study area in the San Joaquin Valley near McKittrick, California at monthly intervals between November 1966 and September 1967. Four plants were sampled from November to March, then, although only small samples were taken, four other plants were chosen to eliminate the possibility of measuring a harvesting treatment. Each sample was oven dried, separated into leaves, new stems, and old stems, and then ground for analysis. Stems larger than 6 mm (.25 inch) in diameter were not included in the sample.

Fat (ether extract) and fiber determinations were made according to procedures of the Association

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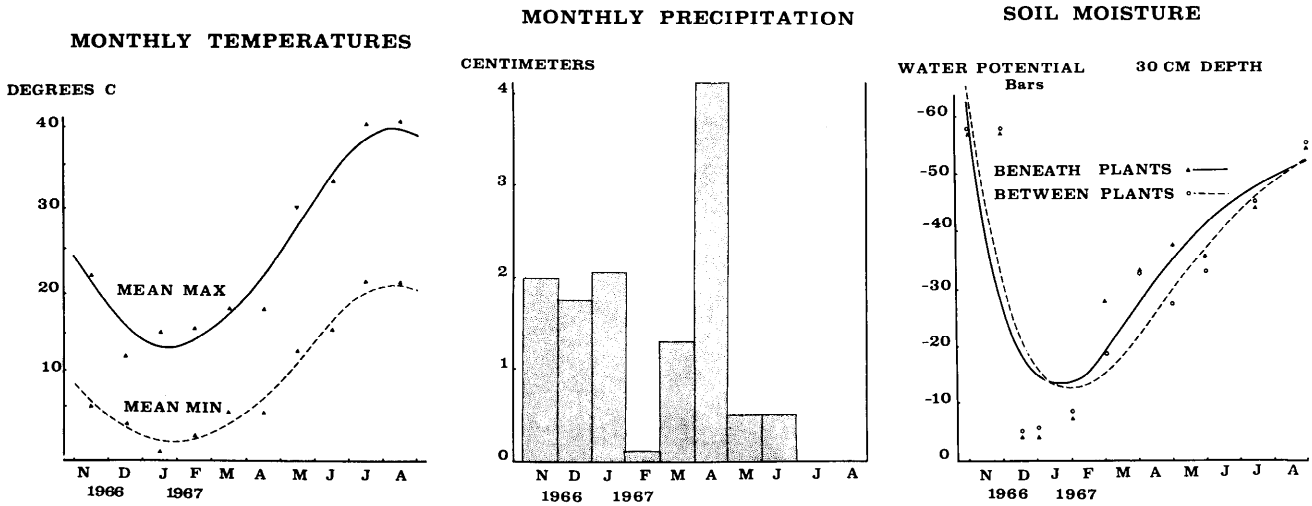

FIG. 1. Environmental conditions at the McKittrick, California study area during the experimental period. Soil moisture was monitored with gypsum blocks.

of Official Agricultural Chemists (1960). Calcium was determined by Na_2EDTA titration after dry-ashing. Following wet digestion, phosphorus was determined colorimetrically by reduction of molybdophorphoric acid complex with stannous chloride. Nitrogen ($N \times 6.25 =$ crude protein) was determined by the micro-Kjeldahl method. Total ash was obtained by muffling the sample at 550 C (1022 F) for two hours. Total digestible nutrients were computed from the digestion coefficients given for saltbushes by Morrison (1959). All results are expressed on a dry weight basis.

Soil moisture conditions were monitored with gypsum blocks concurrently with collection of plant samples. Resistance blocks were placed at two locations with respect to individual plants, directly beneath the crown and at an equal distance between adjacent plants. Replications were placed at depths of 0.3, 0.9, 1.5, 2.25, and 3.0 meters (1, 3, 5, 7.5 and 10 feet) at four sites. Resistance readings were converted to water potential according to McKell et al. (1969). Although values obtained from an extrapolated curve may not be exact in magnitude, trends should be related to the actual changes in water potential. Rainfall and temperature data were taken from the official U.S. Weather Bureau Station at Buttonwillow located near the study area.

Statistical analysis included: (1) analysis of variance and covariance to determine significant differences in chemical composition of plants by collection dates; (2) product moment correlations to compare values for each variable with values of every other variable throughout the year; and (3) weighted polynomial regression to predict curves of values for each component in every plant part throughout the year.

Results and Discussion

Environmental

Air temperatures at the study area ranged from a monthly mean maximum of 40 C (104 F) for August to a mean minimum of –1 C (30 F) in January (Fig. 1). The first frost occurred early in December. Temperatures had risen again by February, sufficient to begin the new season's growth; however, environmental conditions were the most favorable for growth of desert saltbush during May and June.

Precipitation at the study area generally occurs during the winter months, with little if any rainfall in the summer. During the study year, precipitation totaled 12.4 cm (5 inches) (Fig. 1), an amount very near the 11 cm (4.25 inches) mean for the previous 20 years. The low precipitation is reflected in the soil moisture status. Soil moisture increased to the 30 cm depth with the fall rains; however, it decreased steadily throughout the remainder of the season (Fig. 1). Spring rains, which came after the new season's growth of saltbush had begun, were not of sufficient magnitude to alter significantly, the steady decline of soil moisture.

At the deeper levels, soil moisture was always retained at less than –25 bars potential (Fig. 1). At the 30 cm depth, moisture was more positive than –25 bars for fewer than 90 days during the entire year. Apparently, evapotranspiration eliminates most of the precipitation before it penetrates the soil profile to any appreciable depth. The dryness of the soil profile, especially at great depths, may partially explain the relatively shallow root habit of desert saltbush and, in addition, emphasize its drought adaptations.

Forage

Desert saltbush forage from a southern California range showed remarkable variations in the nutritive value in different plant parts at various seasons of the year (Fig. 2).

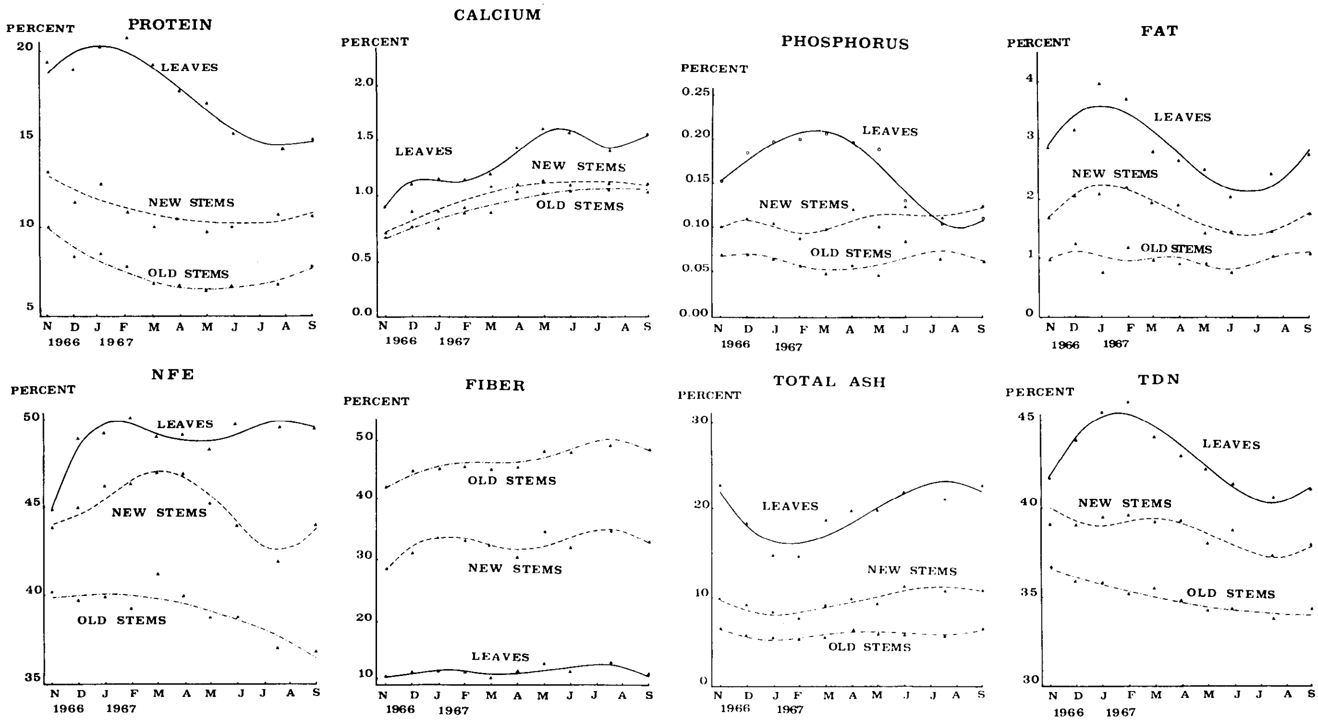

FIG. 2. Chemical constituents of desert saltbush forage collected near McKittrick, California in 1966 and 1967. All percentages are calculated on a dry weight basis.

Leaves.—Leaves were always more nutritious than stems. Leaf samples contained the highest amounts of fat, crude protein, nitrogen free extract, total digestible nutrients, and the least amount of ash, during the cool months of January and February although most of the new growth appeared in May and June (Fig. 2). Values of 2.5–3.5%, 15–20%, and 40–45% were found for fat, protein, and total digestible nutrients, respectively. Such values compare favorably with data given by Morrison (1959) for alfalfa in which he reported 1.9% fat, 15% protein, and 51% total digestible nutrients. Fiber content of the leaves was low compared with the stems and remained relatively constant throughout the year. Calcium varied between 1.0 and 1.5%, which is well in excess of the 0.2 to 0.3% required in a grazing animal's diet (Morrison, 1959). Although the level of phosphorus usually exceeded the required 0.16% (Morrison, 1959), the level dropped below this minimum during late summer. Total ash, found to be predominantly sodium and chloride, varied between 15 and 20% and was highest during late summer. Product moment analyses showed significant positive correlations ($P < 0.01$) between fats, total digestible nutrients, crude protein and phosphorus in the leaves, all of which correlated negatively with total ash.

Stems.—Variations in the chemical content of the stem tissues, throughout the year, were generally much less than for the leaves. Fats and nitrogen free extract in new stems were exceptions; they varied considerably throughout the season and decreased significantly with the new season's growth (Fig. 2). Although calcium in the stems was adequate for animal nutrition, the phosphorus content was not aways sufficient. The calcium:phosphorus ratio exceeded the ideal 2:1 standard; however, the ratio was much less than that reported for *Atriplex confertifolia* and *A. canescens* (Cook et al., 1959). Fats in the new stems were always less than within the leaves and their values followed the same pattern in both plant parts throughout the year. For most other components there was no close correlations ($P > 0.05$) between values in the stems as compared with those in the leaves.

Environment-forage-quality correlations.—Crude protein, phosphorus, fats, and total digestible nutrients in the leaves had significant negative correlations ($P < 0.01$) with the monthly mean maximum air temperatures, as well as the minimum. Soil moisture had no correlation with any of the plant components.

Summary

A study was made of the forage value of desert saltbush in the San Joaquin Valley, California. Plants were sampled concurrently with soil moisture measurements over a 1-year period. The highest forage values were found during the cool, moist season of the year—November through March—even though most of the new growth occurred in May and June. While calcium in the leaves and new stems averaged more than 1%, well in excess of the 0.2 to 0.3% required in an animal's diet, phosphorus averaged

0.14%, slightly less than the 0.16% required. However, the quantity of phosphorus present in the forage was less than adequate only during a short period in the late summer. Values for crude protein, total digestible nutrients, and fat were comparable to those for alfalfa.

The soils supporting desert saltbush were found to be very dry throughout most of the year and generally had a water potential of less than –25 bars. Adaptation to such extreme drought conditions coupled with its acceptable nutritional forage values and salt tolerance (Chatterton and McKell, 1969; Chatterton et al., 1969) makes desert saltbush a valuable range plant in the arid regions of the Southwest. Desert saltbush provides a good source of calcium, phosphorus, and protein as well as carotenoids, especially late in the year when the annual forage has reached maturity and many nutritional components have been lost. The browse value of desert saltbush is often exemplified by its association with unpalatable species. It is often the only shrub present on extensive areas that are too arid or saline for other less-drought-tolerant or less-salt-tolerant forage plants.

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