Forage Yields of Five Perennial Grasses with and without White Clover at Four Nitrogen Rates

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Highlight: One of the current interests in cattle production research is the inclusion of a legume which might be expected to increase forage yields and reduce the need of N fertilization. The clover should lengthen the growing season over that of straight grass. An investigation measured the influence of white clover on grass forage yields where perennial grass species were grown at four N rates with and without white clover (*Trifolium repens* L.). White clover/perennial grass mixtures were superior to grass/N, and including clover significantly increased forage yields at N rates up to 112 kg/ha. Only when 336 kg N/ha was applied were average yields of clover/grass and grass/N comparable. The average increase in forage yields when clover was added to the perennial grasses at the 0, 37, 112, and 336 kg/ha N rates was 218.9%, 93.0%, 34.1%, and 0.2%, respectively. Clover production was concentrated in the first 7 months of the season and dropped sharply in August and September. Average clover/grass yields were consistently higher over the 4 years than were grass/N yields. White clover should be included in grass mixtures grown in Southern pastures to reduce the need for N fertilization.

There are an estimated 197 million acres, 80 million ha, of Southern range, most of it grazed by either wildlife or cattle sometime during the year (Williams et al. 1955). Practically all Southern ranges are seasonal and their successful use is usually dependent upon being combined with cultivated pastures where cattle can be cared for during the 6 to 7 months when they should be off the range.

Nitrogen fertilization of grass pastures and hay baling have been used widely to increase forage production and preservation. However, both are expensive, and using clover to replace N in forage production and field stockpiling reduces both production and harvesting costs. Farmer interest in reducing production cost is high.

Coastal Bermudagrass has been extensively researched for forage production in the South, and limited research has been completed on common Bermudagrass and tall fescue. Forage research on Dallisgrass and orchardgrass is not current, and research on the contributions of white clovers when grown with the major grasses is almost not existent.

All of these forage plants are grown somewhere in the Southeast. A knowledge of the different growth patterns would be extremely helpful to ranchers who must grow tame forages to provide fall forage for grazing during drouths and for wintering when cattle are not allowed to graze the ranges.

White clover (*Trifolium repens* L.) is one of the most versatile and in many instances the most durable of the clovers. It is adapted over much of the world and the southeastern United States but has received little research attention during the last two decades. Some of the last research on white clover in forage mixtures was that reported by Blaser et al. (1956), where the difficulty of maintaining white clover in pastures was reported.

In the 1940's, white clover stands were difficult to maintain due primarily to varied disease, fertility, and physiological limitations (Gibson 1957; Jones and Tisdale 1921; Kreitlow et al. 1957). Various viruses have been shown to reduce clover stands (Smith and Gibson 1960), and high soil and air temperatures tend to interfere with nodulation, flowering, and persistence. Generally, nonflowering clover plants out-yield and persist longer than flowering types. However, flowering types which produce seed are able to re-establish after stand loss, while non-seed producers are not. In the early white clover research, ladino was popular, but by 1955, it was recognized that ladino white clover was not persistent and was being replaced by seed-producing types.

Johnson, Donnelly, and Gibson (1970) developed 'Regal' white clover, which is more disease resistant and physiologically less susceptible to high temperatures; and it is now grown in place of ladino. Carter and School (1962) have obtained increases in forage yields by including white clover in planting mixtures, while others have reported no significant increases in forage yields (Templeton and Taylor 1966).

Early research with white clover tended to concentrate on the fertility, disease, and physiological problems associated with stand maintenance. Little emphasis was placed on white clover's contribution to a grass sod in terms of increased yield, seasonal distribution of yield, and quality of the forage.

Forage yields of Coastal Bermudagrass and tall fescue when grown alone have been reported (Beaty et al. 1973; Taylor and Templeton 1976), but data on yields when white clover is included are not widely available. Present indications suggest the grasses are likely to be grown with clover in the future.

Cowling and Lockyer (1965) con-

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cluded that the grass and white clover components of a mixture were inversely related to N application or soil N. Growing white clover with grasses was found to be equal in increased yield to that obtainable from the application of 120 to 205 pounds of N/acre (134–230 kg/ha) to the grass without clover.

This investigation was completed to determine the yields of several perennial grasses in the lower South, using grass without clover and white clover/grass mixtures each grown at various N rates. A second objective was to establish yield modifications produced by including white clover and duration of the influence.

Materials and Methods

Tall fescue (*Festuca arundinacea* Schreb.), orchardgrass (*Dactylis glomerata* L.). Dallisgrass (*Paspalum dilatatum* Poir.), 'Coastal' and common Bermudagrass (*Cynodon dactylon* L. Pers.) were grown as whole plots on Fannin clay loam, a fine loamy mixed mesic family of the Cumulic Haplumbrepts, with and without ladino clover (*Trifolium repens* L.) as split-plots. Plots were further split for nitrogen (N) variables of 0, 37, 112, and 336 kg/ha as ammonium nitrate in three applications annually. Treatments were replicated five times, and forage harvests were made on approximately May 1, June 15, August 1, and September 20. Only tall fescue and orchardgrass plots were clipped at the first harvest, but all plots were harvested at clippings 2, 3, and 4. Yields of dry forage were determined by clipping a 75-cm swath to a stubble height of 6.3 cm through 6.3-m long plots. Forage was dried with forced heat.

Phosphorus (P) and potassium (K) were applied annually as 560 kg/ha of 0-4.4-16. Forage yields were collected for 4 years and botanical composition was determined on the grass/clover treatments of all grasses for 1952 and 1953.

Results and Discussion

Grass forage averaged 1,029 kg/ha without clover or N, but clover increased forage production to 3,284 kg/ha or 219%. Grass yields were doubled to 2,046 kg/ha by applying 37 kg of N; adding the white clover increased the total yield an additional 93% to 3,946 kg/ha. When 112 kg of N was applied, four times as much grass forage was produced as with 0 N but the clover added an additional 1,378 kg or 34%. Only at the 336 kg N rate were grass yields equal to grass and clover yields (Fig. 1).

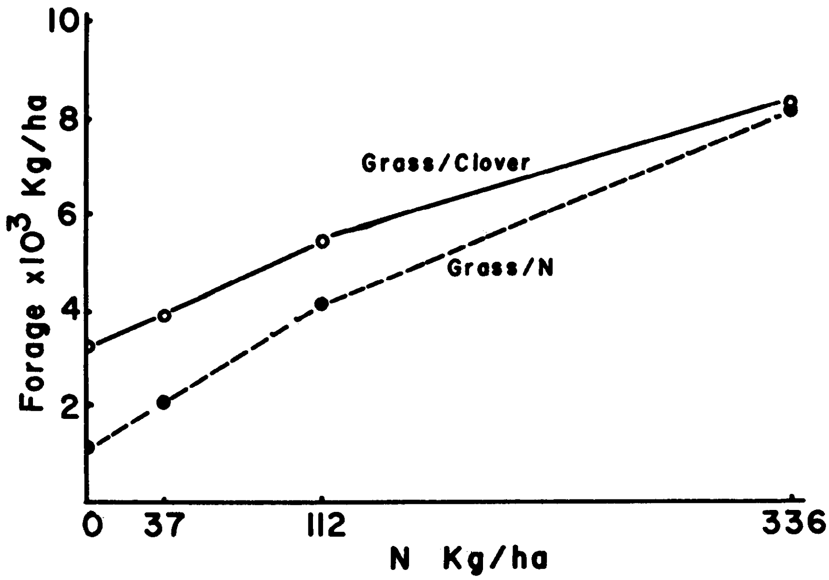

Fig. 1. *Average dry forage yield of tall fescue, orchardgrass, Dallisgrass, Coastal and common Bermudagrass with and without white clover at four N rates. Four-year average. Blairsville, Georgia 1952-1955.*

White clover was an advantage in grass sods, with the greatest benefit at low N levels. In terms of increased forage production, forage produced by grass/clover at zero N was equal to approximately 96 kg of N applied to grass alone and compares favorably with that reported by Cowling and Lockyer (1965). Except for hay production, N fertilization of pastures is usually below 100 kg/ha, indicating justification for renewed interest in legumes in general and in white clover specifically. Yield data for Coastal Bermudagrass with/without clover are shown in Figure 2. Bermudagrass, being more efficient photosynthetically, would be expected to produce more forage than the orchardgrass. (Chen et al. 1969). White clover grew equally well with either cool- or warm-season grasses (Table 1). Yield data for all forage grasses, with/without clover, included in the investigation are shown in Table 1. Forage yields of Dallisgrass, common Bermudagrass, and tall fescue at the different N rates with/without white clover followed a yield trend similar to that of Coastal Bermudagrass and orchardgrass and yield data are shown in Figure 2.

Yield data were from a uniform clipping height and do not insure harvesting a uniform percent of all species present. Different plant growth types as well as amount of forage present will appreciably influence the amount harvested (Beaty et al. 1973). Ethredge et al. (1973) showed that reducing clipping height from 14 to 0 cm increased the yield of Coastal Bermudagrass 161% when no N was applied but 68% with 448 kg N per ha. It is probable that forage yields of the

Table 1. Yield of five forage grasses under influence of N fertilization.[1]

Grass	kg N/ha 0	37	112	336
Orchardgrass	1290*	2000	3780	6840
Orchardgrass with white clover	3250	3590	5270	7260
Tall fescue	360	1240	2720	6050
Tall fescue with white clover	2540	2690	4000	6650
Coastal Bermudagrass	1230	2310	5120	10300
Coastal Bermudagrass with white clover	4170	5020	6370	10240
Common Bermudagrass	1070	2410	3830	8510
Common Bermudagrass with white clover	3600	4300	5760	7990
Dallisgrass	1190	2260	4770	9180
Dallisgrass with white clover	2860	4130	5710	8820

[1] Over a 4-year average.
**LSD:* 0.05 366 kg/ha.

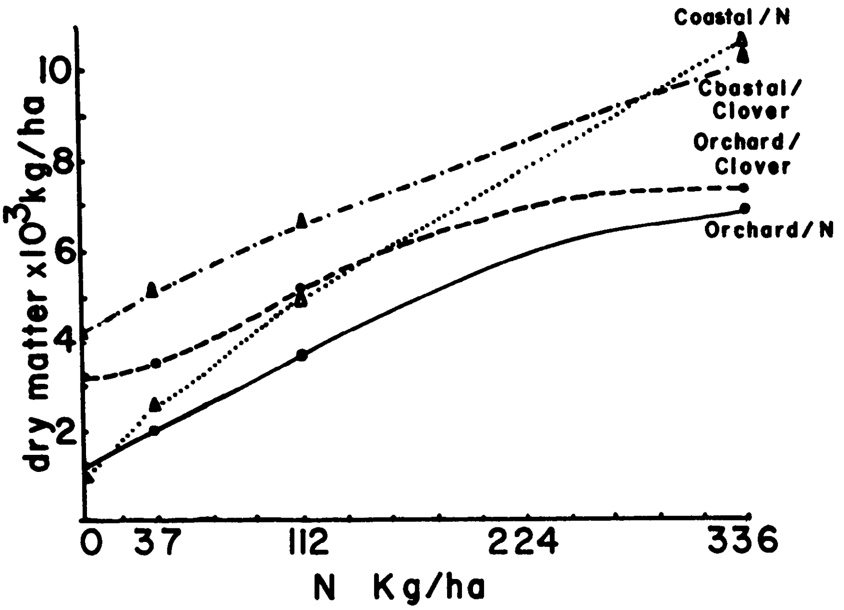

Fig. 2. *Average dry forage yield of orchardgrass and Coastal Bermudagrass with and without clover at four N rates. Four-year average. Blairsville, Georgia 1952-1955.*

low growing tall fescue, Dallisgrass, and common Bermudagrass represent a smaller percentage of the forage present than do the yields of the upright growing orchardgrass and Coastal Bermudagrass. Care should be exercised when comparing yields of grasses with different growth types as forage yields reflect height of harvesting and low growing ones may have yields underestimated.

Only tall fescue and orchardgrass plots were harvested at the first clipping but all plots were harvested at clippings 2, 3, and 4. When total annual yields are fractionated to percent of total, 25% of tall fescue alone was harvested at the first clipping and 50% at the second. Clippings 3 and 4 accounted for 12.4% each. Inclusion of clover had no influence on percent of yield harvested at the first clipping, reduced the second by 7%, and increased the third 5% as compared to the grass alone. The fourth clipping, with 12.4% of the annual yield for tall fescue alone, was not significantly influenced by the inclusion of clover, which had 13% of the year's total production.

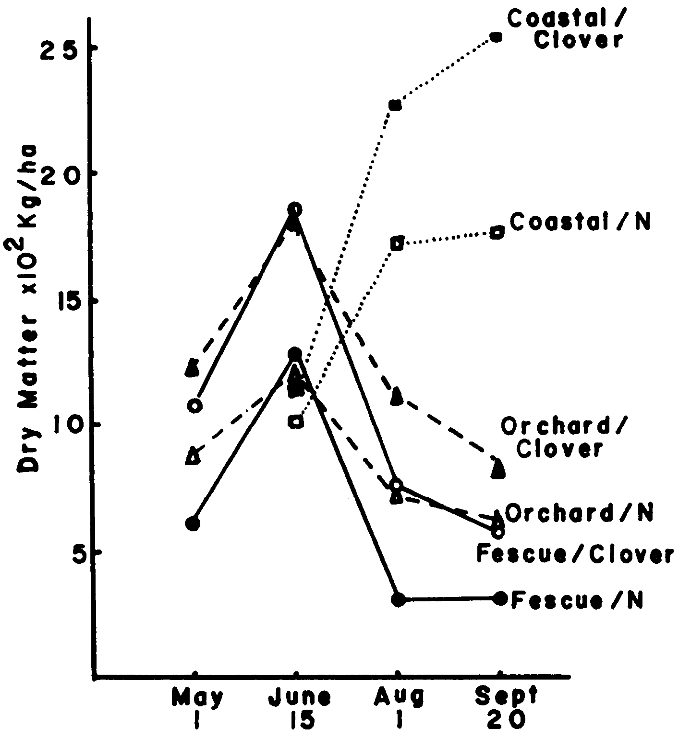

Fig. 3. *Average dry forage yield of tall fescue, orchardgrass, and Coastal Bermudagrass with and without clover by harvest dates. Average over 4 years at four N rates. Blairsville, Georgia 1952-1955.*

Orchardgrass and orchardgrass with clover were much more evenly distributed through the season than were tall fescue or tall fescue and clover. Orchardgrass alone was split 26.0, 35.5, 20.4, and 18.2% among harvests 1 through 4, respectively. When clover was added, the distribution of forage production was split 24.4, 36.7, 33.4, and 16.4% among the same harvests. Orchardgrass has been recognized for some time for having greater regrowth than tall fescue has during the summer and fall (Washko et al. 1967). The three summer-growing grasses followed a seasonal production trend which was significantly different from that of the cool season grasses. The second harvest (first for the summer-growing grasses) was small and highest average forage were obtained at the third harvest, with a small decline for the Dallisgrass and common Bermudagrass with white clover occurring at the fourth harvest.

In general, presence of white clover in the mixture increased forage present at all clips as compared to grass alone but had little influence on total seasonal distribution. Early growth of tall fescue and orchardgrass is shown in Figure 3, as is the significant reduction of growth in summer and fall. Growth of Dallisgrass and Bermudagrasses was low at the June 15 harvest and high at the August 1 and September 20 harvests. Seasonal forage distribution of monospecific summer-growing perennial grasses with N compared poorly to that produced by a cool-season grass growing with one of the warm-season grasses.

The lowest annual cultivar yield when averaged over four N rates was tall fescue without white clover at 2,593 kg/ha; this was followed by orchardgrass with 3,478 kg. Common Bermudagrass had an average yield of 3,955 kg/ha. Dallisgrass producing 4,350 and Coastal Bermudagrass producing 4,740 kg/ha were highest yielders. Average yield of all grasses over all N rates was 3,818 kg/ha, which was 1,393 kg/ha lower than the 5,211 kg/ha when white clover was included.

Average forage yield in 1952 was 3,678 kg/ha, followed by 3,789 kg in

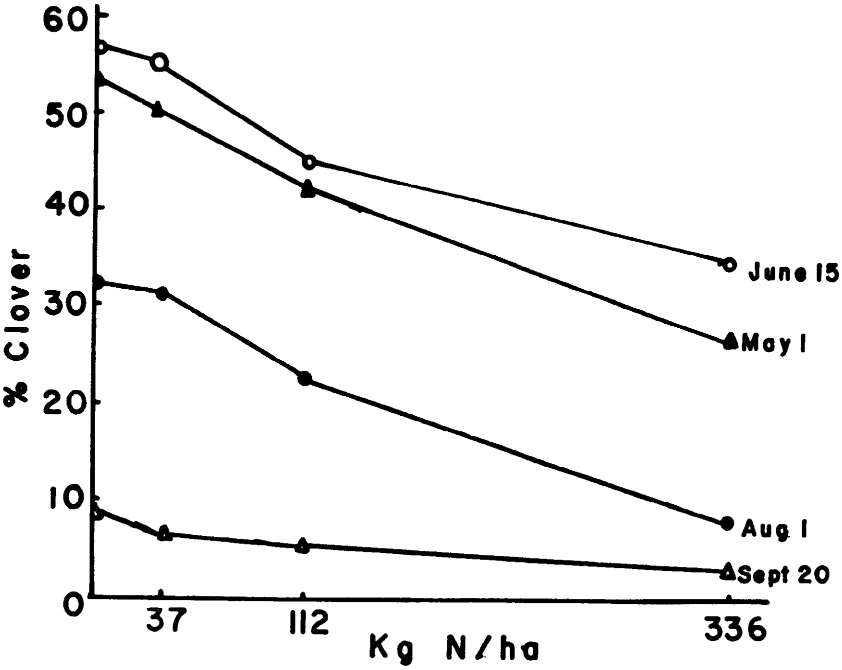

Fig. 4. *Average percent white clover content of tall fescue, orchardgrass, Dallisgrass, Coastal and common Bermudagrass by four N rates and four harvest dates. Clipping one included tall fescue and orchardgrass only. Other clippings include all grasses. Blairsville, Georgia 1952-1953.*

1953. In 1954, dry weather reduced the average forage yield by 300 to 400 kg/ha or approximately 10%. Increased rainfall in 1955 caused yields to increase 15% above the average (Fig. 5).

Average yields of grasses with clover were highest in 1955 when 6,087 kg/ha were produced, as compared to 4,613 kg/ha for the monocultures. Forage production during the other 3 years was similar, with average grass forage production being 3,686, 3,730, and 3,258 kg/ha for 1952, 1953, and 1954, respectively. When clover was added, average forage production was 4,768, 5,119, and 5,024 for the same 3 years.

In 1954 grass production was reduced somewhat by dry weather, but grass/clover yield was similar to that obtained in 1952 and 1953. The data would suggest that during years when grass growth is reduced, clover may grow more in the reduced competition. During favorable years when grass growth is vigorous, clover growth may be reduced. Clover growth in years unfavorable for grass growth should compensate for the reduced grass growth; and during years favorable for grass growth, clover growth may be reduced. The higher clover production in 1954 is attributed to dry weather reducing competition of the grasses.

The relatively poor forage production of fescue as compared to orchardgrass is possibly due to growth habit. Tall fescue, particularly at low fertility levels, tends to produce tillers that grow at sharp angles from the vertical (Bahrani 1973) while orchardgrass produces tillers that grow more vertically. When harvesting at a given height, more of the orchardgrass will be harvested than the tall fescue. As a consequence of removing a greater percent of the orchardgrass present, yields should be higher than tall fescue yields and clover would be expected to grow better with upright growing grass tillers or where more forage is removed at harvest. The data in Figure 3 show that the orchardgrass/clover combination did yield more than fescue/clover by some 853 kg. A similar effect is also shown where the upright growing Coastal Bermudagrass with its open sod yielded more than the low growing common Bermudagrass with a closed sod.

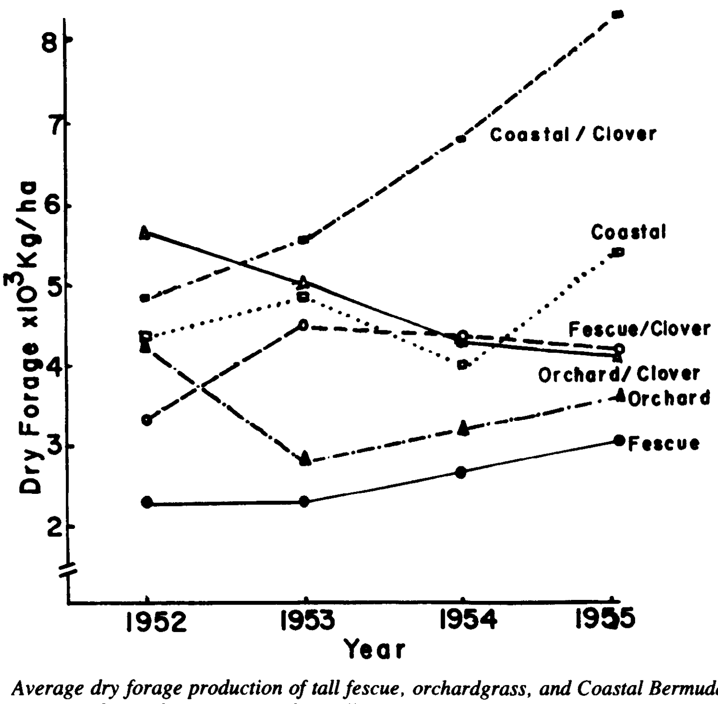

Fig. 5. *Average dry forage production of tall fescue, orchardgrass, and Coastal Bermudagrass by years. Averaged over four N rates. Blairsville, Georgia 1952-1955.*

Harvest management and fertilizers required to maintain a given white clover content in these perennial grasses were not evaluated specifically. However, increasing N application reduced percent clover in the mixture (Fig. 4). As sod density of perennial grasses tends to increase with heavier N applications, heavier grazing or closer clipping of spreading type forage grasses would appear to be favorable for clover establishment and production. This concept appears to support the report of Cowling and Lockyer (1965).

Difficulties of keeping white clover in rotationally grazed pastures have been noted (Blaser et al. 1956), but no data were provided as to the amount of forage present. Removing the forage by mowing as in this investigation probably reduced competition between grass and clover. Height of clipping or grazing probably will have a significant effect on clover retention. Young tillers tend to grow horizontally until sod is formed, and as the sod thickens, the tillers grow more upright. Thus, a lax clipping or grazing regime that allows an accumulation of forage shades the soil and interferes in the germination, establishment, and growth of annual seedlings and probably low growing clovers as well. It is probable that a multi-species pasture can be attained in the southeastern United States by limiting the N fertilization, utilizing the dense, sod-forming grasses to a height of less than 4 cm, and using persistent clover cultivars such as 'Regal' or 'Tillman.'

Using white clover to replace N and field stockpiling of forage for wintering should significantly reduce the cost of cattle production. One of the grasses tested is adapted throughout the range areas of the South. Combining range with cultivated pastures was considered to be a good practice by Williams et al. in 1955 and is probably a necessary one now.

Integrating cultivated pastures and ranges will probably include provisions for both grazing and hay, which can be made during the summer while cattle are grazing the range. The range plants are summer-growing species and in general require a rather specific time-related management.

The tall fescue and orchardgrass are cool-season perennials well adapted to either fall and winter grazing or field stockpiling. Tall fescue is sometimes seeded in clean-cut areas to prevent soil erosion. It could well be integrated into range grazing schemes to complement the time of grazing the native plants.

Dallisgrass growth is usually associated with heavy or wet soils. Such areas may not be adapted to growing specific trees, and an alternative use could well be forage for grazing during drouths. Including the white clover would essentially eliminate the need for N fertilization.

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The Botanical Composition of Cattle Diets on a 7-Pasture High-Intensity, Low-Frequency Grazing System, by Charles Andrew Taylor, Jr., MS, Range Science, 1973.

The botanical and nutritive composition of cattle diets were determined on a 7-pasture high-intensity, low-frequency grazing system in the Edwards Plateau region of Texas. Five esophageally cannulated heifers were used for 22 collection periods from September 24, 1971, to May 11, 1972. Diets were collected in each pasture during the first 3 days and last 3 days of each grazing period. Forage available for consumption was measured prior to the movement of animals into the pasture.

Though cattle selected grass as the major component of the diet, forbs, pricklypear, and browse were highly significant components at different periods during the study. Higher percentages of forbs, lower percentages of pricklypear and browse, and about equal amounts of grasses were consumed in the first 3-day collection periods compared to the last 3-day collection periods. Grass consumption tended to be greater during the fall and spring season than during the winter, while forbs were highly selected throughout the study. Pricklypear was utilized fall and spring. Browse was important in the diet in the spring.

Forbs were the most preferred class of forage. Grasses were consumed in proportion to their availability during the fall, but during the winter they had negative preference values. Pricklypear has negative preference values for the fall period but was highly preferred in two pastures during the winter period.

The nutritive composition of diets varied considerably between collection periods A and B and reflected changes in the botanical composition. Crude protein levels were usually higher for the first 3 days than for the last 3 days of the grazing periods. Larger amounts of ash in the diets were associated with greater consumption of pricklypear. Neither cell walls nor in vitro organic matter digestibility differed significantly between the two collection periods. Higher levels of cell walls in the diet were normally associated with a greater consumption of grasses. In vitro digestibility of diets from pastures grazed in the spring was higher than for other periods of the year and paralleled the initiation of growth from the warm-season perennial grasses and browse.