Carbohydrate and Nitrogen Reserve Cycles for Continuous, Season-long and Intensiveearly Stocked Flint Hills Bluestem Range

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Highlight: Effects of intensive, early stocking (twice the normal stocking rate from May 1 to July 15) and continuous, season-long stocking from May 1 to October 1 with yearling steers on big bluestem carbohydrate and reserve cycles were studied 3 years in the Kansas Flint Hills. Big bluestem reserve carbohydrates were similar during the dormant season under both stocking systems, but lower on the intensive-early stocked pasture during mid-summer than on the continuous, season-long stocked one. By growing season's end carbohydrate reserves were similar for both stocking systems. Stocking system did not affect the nitrogen reserve cycle. Big bluestem vigor and regrowth potential were similar for both systems.

Efficient conversion of Kansas Flint Hills range forage to beef may necessitate grazing by growing animals only during the high forage quality period (May 1–July 15) when livestock gains are highest at an above normal stocking rate. Increased stocking rates during that period do not reduce individual animal performances (Launchbaugh 1957; Klipple 1964). Since animals use the range when gains are highest, and not during the period of lower livestock gains in the latter half of the growing season (July 15-October 1) both per head and per acre performances should increase.

The desirable range plants must be able to withstand intensive early grazing and recover their vigor by season's end before the grazing scheme proposed above could sustain itself for many years. Carbohydrate (CHO) reserve research with big bluestem (*Andropogon gerardi* Vitman.) in the Kansas Flint Hills indicated full recovery of vigor on areas mowed to 2 inches in early June and July (Owensby et al. 1970). Sufficient regrowth in the late season produced CHO reserve storage equal to or exceeding that of unmowed areas. Work elsewhere with different species indicated that defoliation early in the growing season was less likely to reduce food storage in grasses than late-season defoliation (Sampson and McCarty 1930; Drawe et al. 1972; Trlica and Cook 1971).

We studied the effects of intensive early stocking (2X) from May to July 15 and continuous season-long stocking (1X) from May 1 to October 1 with yearling steers on carbohydrate and nitrogen reserves of big bluestem.

Materials and Methods

The study area was two 60-acre pastures in the northern Kansas Flint Hills near Mahattan (Fig. 1). Big bluestem, Indiangrass (Sorghastrum nutans (L.) Nash), and little bluestem (Andropogon scoparius Michx.) were the major dominants. Numerous other perennial grasses and forbs constituted the remainder of the plant community. Soils were transitional from udic ustolls to udolls. The principal range sites in the study area were loamy upland, breaks, and clay upland, all supporting tallgrass communities (Anderson and Fly 1955).

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Fig. 1. Experimental pastures in the northern Kansas Flint Hills.

Thirty-six yearling steers (450–500 lb) were grazed on one 60-acre pasture from May 1 to July 15 (2.5 acres/AU) each year, 1972 through 1974 with no grazing between July 15 and May 1. Another 60-acre pasture was continuously grazed by 18 yearling steers from May 1 to October 1 (5.0 acres/AU) those same years, with no grazing between October 1 and May 1. Each pasture was burned during the last 10 days of April each year (Fig. 2).

Samples for determining total nonstructural carbohydrates (TNC) and nitrogen (N) were collected from three loamy upland range sites within each pasture every 2 weeks from April 1 to December 1 and once a month the remainder of the year. At each collection site within a pasture a minimum of 20 big bluestem plants were selected at random along and within 1 yard either side of a 100-yard line. Plants were dug deep enough (about 6 inches) to insure that rhizomes were collected. Soil, roots, and dead organic material were removed by cold-water washing and hand clipping. Cleaned samples of rhizome, crown, and live stem bases were oven dried for 5 days at 70°C, ground in a Wiley mill (40-mesh screen), and stored in the dark. TNC was determined by enzyme extraction (takadiastase) and copperiodometric titration (Smith 1969). Nitrogen content was determined for each sample collected for TNC analysis by the Kjeldahl process (Hiller et al. 1948).

Results and Discussion

Big bluestem reserve TNC levels were similar for both stocking systems from October 15 to April 1 (Fig. 3). From May 15 to August 1 TNC reserves on the intensive early-stocked pasture were progressively lower than those of the continuous season-long stocked one. By September 1, 6 weeks after livestock were removed from the intensive early-stocked pasture, TNC reserves were similar for both stocking systems and remained so until the beginning of the next growing season. Since livestock were removed from the intensive early-stocked pasture July 15, the regrowth had sufficient time to replenish



Fig. 2. Spring burning of Flint Hill range.

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Fig. 3. Big bluestem reserve total nonstructural carbohydrate (TNC) at different dates for continuous, season-long and intensive early-stocked pastures (1972–74 average). Asterisk above a date indicates a significant difference (P<.05).

TNC reserves before frost (about October 15). Warm-season perennial grasses like big bluestem and others of similar phenology should be able to maintain their competitive status and productivity in the stand under intensive early use, based on the data from this study. Botanical census of the areas indicated big bluestem had increased in basal cover and relative abundance in the stand under intensive early stocking and had remained static under continuous season-long stocking (Owensby and Smith 1975).

Certain declines in reserve carbohydrates are apparent during the yearly cycle (Fig. 3). The initial growth period results in a drawdown of reserve carbohydrates with a period of storage following. McKendrick et al. (1975) reported that lowered TNC reserves for big bluestem and Indiangrass in late August were associated with root growth on new rhizomes. We found a similar decline in reserve carbohydrates then. Another period of apparent carbohydrate reserve use came during mid-winter. No external change in morphology could be detected, and we hypothesized it was an internal chemical conversion, possibly associated with winter hardiness. Subsequent study revealed that method used in carbohydrate extraction was important. Enzyme extraction with takadiastase indicated a drop in reserve carbohydrates, but not when sulfuric acid extraction was used. Apparently, some carbohydrate form exists then that is not extractable by enzyme but is by acid extraction. Coincident to the drop in carbohydrate reserve was freezing of the soil 3-4 inches.

Stocking system had no apparent effect on big bluestem nitrogen reserve cycle (Fig. 4). Nitrogen reserve declined from the beginning of the growing season until mid-August and was



Fig. 4. Big bluestem reserve nitrogen at different dates for continuous, seasonlong and intensive early-stocked pastures (1972–74 average).

replenished during the next 2 months. Increases in reserve nitrogen were coincident to root growth on new rhizomes. The primary decline came between May 15 and July 1 during the accelerated growth phase of big bluestem. Rains et al. (1975) and McKendrick et al. (1975) reported similar nitrogen reserve cycles for big bluestem. Those authors along with Weinmann (1942) have indicated the internal migration of nitrogen from the aerial portion of the plant to storage areas constituted a nitrogen reserve. McKendrick et al. (1975) reported that 18% of the total nitrogen need for big bluestem and Indiangrass came from an internal nitrogen reserve. If, as Crider (1955) indicates, root growth ceases following severe defoliation for an extended period, a nutrient reserve would be necessary since most nutrient uptake is dependent upon active root growth. Regrowth and spring growth potential are related to nitrogen reserves as well as to carbohydrate reserves, and intensive early stocking had no apparent adverse effects on nitrogen reserves compared with conventional, continuous season-long stocking.

Conclusions

1. Intensive early stocking of bluestem range does not reduce big bluestem carbohydrate reserves at growing season's end compared with continuous, season-long stocking.

2. Big bluestem carbohydrate reserves are lower during mid and late summer under intensive early stocking than under continuous, season-long stocking, but recover by the end of the growing season.

3. The stocking systems studied had no effect on the nitrogen reserve cycle.

4. The nitrogen reserve cycle was primarily affected by accelerated growth.

5. Intensive early stocking can be used to maximize per ac beef production without degrading the plant community.

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