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SEASONAL VARIATION IN NUTRITIVE VALUE OF *CHRYSOPOGON AUCHERI* (BOISS) STAPF., AND *CYMBOPOGON JWARANCUSA* (JONES) SCHULT., IN HIGHLAND BALOCHISTAN, PAKISTAN

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Abstract

Chrysopogon aucheri (Boiss) Stapf., and *Cymbopogon jwarancusa* (Jones) Schult., are the dominated perennial range grasses in highland Balochistan. Seasonal concentration dynamics of nitrogen (N), phosphorus (P), magnesium (Mg) and calcium (Ca) in *Chrysopogon aucheri* and *Cymbopogon jwarancusa* were determined at a protected site. The concentration of nitrogen in spring ranged from 12.4 to 13 mg g^{-1}, early summer 15.4-17.26 mg g^{-1} and late summer 6.7 to 10.7 mg g^{-1}, respectively during 2001 and 2002 seasons. In 2001, the concentration of P in spring and early summer was (1.1-3.4 mg g^{-1}) and least in late summer (0.26-0.81 mg g^{-1}) while in 2002 the concentration of P in spring and early summer was significantly higher (1.28-3.35 mg g^{-1}) and least in late summer (0.38-1.01 mg g^{-1}). In both grass species, there was a similar response of concentrations of K, Mg and Na and the concentration of these elements were higher during spring and then dropped and remained static for the remainder of the year while the concentration of Ca was lower in early spring and significantly ($p<0.05$) increased with the passage of time during the season. In both grasses the N: P ratio was below < 14 suggesting N-limitation during March and July and showed more than >16 during drier months of August and September. Overall, both the grasses are low in N, P and other nutrients except Na and Ca. These findings suggest that heavy but short-term grazing of very long protected grasslands after substantial rainfall may be one strategy to increase palatability and animal nutrition. Results of this study also indicate the need for direct and high quality mineral supplementation for grazing stock.

Introduction

In Balochistan, around 93% (87.81 million ha) of the total area is classified as rangeland that supports about 20 million small ruminants (Anon., 1983). These rangelands have low productivity due to environmental constraints and mismanagement and their carrying capacity has been seriously diminished (Hussain & Durrani, 2007). Overgrazing and removal of vegetation for fuel has depleted the natural vegetation and there is a serious shortage of forage for sheep and goats during winter months. The grasslands of Balochistan are situated in the eastern and northeastern parts where annual rainfall is 250 to 300 mm. *Chrysopogon aucheri* and *Cymbopogon jwarancusa* are the dominant C_4 perennial bunchgrasses and found growing on a wide variety of soils over a wide range of elevation (Ahmad *et al*., 2000).

Generally, plant species in Balochistan are deficient in total digestible nutrients and in digestible protein and dry matter with respect to animal requirements (Anon., 1983). Most of the native range species in highland Balochistan are deficient in nitrogen and phosphorus for at least part of the year and limit livestock production (Wahid, 1990). The nutrient deficiency leads to under nutrition and low productivity of livestock (Rahim *et al.*, 2008). The daily nutrient demand of livestock varies in accordance with the physiological functions of the grazing animals and patterns of maintenance, gestation,

fattening and lactation play major roles in determining daily nutrient requirements (Cook & Harris, 1977). The chemical and nutrient composition of plants and plant communities in rangelands varies according to climate, species, soil type, plant phenology and other abiotic factors (Greene *et al*., 1987).

The main consideration in livestock production on rangelands is the decline of nutritive value of grasses as the growth approached towards maturity (Kothumann, 1980). To improve productivity and forage utilization, it is necessary to have knowledge of nutritive value of range species and their impact on livestock production. Previously, in Balochistan most of the research was focussed on quantifying the crude protein and energy content of the available forage (Islam & Adams, 2000) with only limited research focussed on quantifying the seasonal dynamics of minerals. The main objective of this study was to characterize the seasonal concentration dynamics of nitrogen (N), phosphorus (P), magnesium (Mg), and calcium (Ca) in two dominant grasses viz., *Chrysopogon aucheri* and *Cymbopogon jwarancusa*.

Materials and Methods

The experiment was conducted at Hazarganji National Park, 20 km South of Quetta, Pakistan (30º 07' N, 66º 58 E) during 2001-2002. The site has a Mediterranean climate. The region is characterized by highly variable annual and seasonal distribution of rainfall. Surface soils (0-10 cm) at the study site had a pH of 7.1(± 0.5); organic matter concentration of 1.89%; nitrogen concentration of 0.14%, a concentration of available phosphorus of 3.8 ppm (Ahmad *et al*., 2000).

Three blocks each of 50 x 50 meters were established at a representative site dominated with *Chrysopogon aucheri* and *Cymbopogon jwarancusa* vegetation. On monthly basis (from April), samples of both grasses were collected from each plot. Representative samples of the foliage were collected from at least 10 individuals of each species in each plot and bulked. Plant material was dried at 70ºC for 24 hours and finely ground using a ball mill. Laboratory analyses of the dried plant material included colorimetric assays of total N and P (Keeney & Nelson 1982; Murphy & Riley, 1962) after Kjeldahl digestion. The same digest was used for the analysis of Na, K, Mg and Ca *via* atomic absorption spectrophotometry as described by (Adams & Attiwill, 1986). Results were analyzed using an analysis of variance. Least significant differences (LSD) were used to compare treatment means at a significance level of $p<0.05$.

Results and Discussion

The total rainfall during 2001 and 2002 was 82.8 mm and 172.3 mm compared to long-term average of 250 mm. In both years, variations with the time (season) of sampling on foliar concentrations of both species (*Chrysopogon aucheri* and *Cymbopogon jwarancusa*) of all nutrients were highly significant ($p<0.05$) (Fig. 1). Concentration of both N and P in current season growth changed in concert with changes in biomass. In 2001 and 2002, the concentration of N was significantly different ($p<0.05$) between months and significant differences were observed between species i.e., the concentration of N was higher in *Chrysopogon aucheri* than *Cymbopogon jwarancusa*. On a seasonal basis, in 2001, the concentration of nitrogen in spring and early summer was 12.4-15.4 mg g^{-1} and least in late summer (7.12-10.5 mg g^{-1}) while in 2002 the concentration of Nitrogen in spring and early summer was significantly higher (13-17.26 mg g^{-1}) and least in late summer (6.7-10.7 mg g^{-1}).

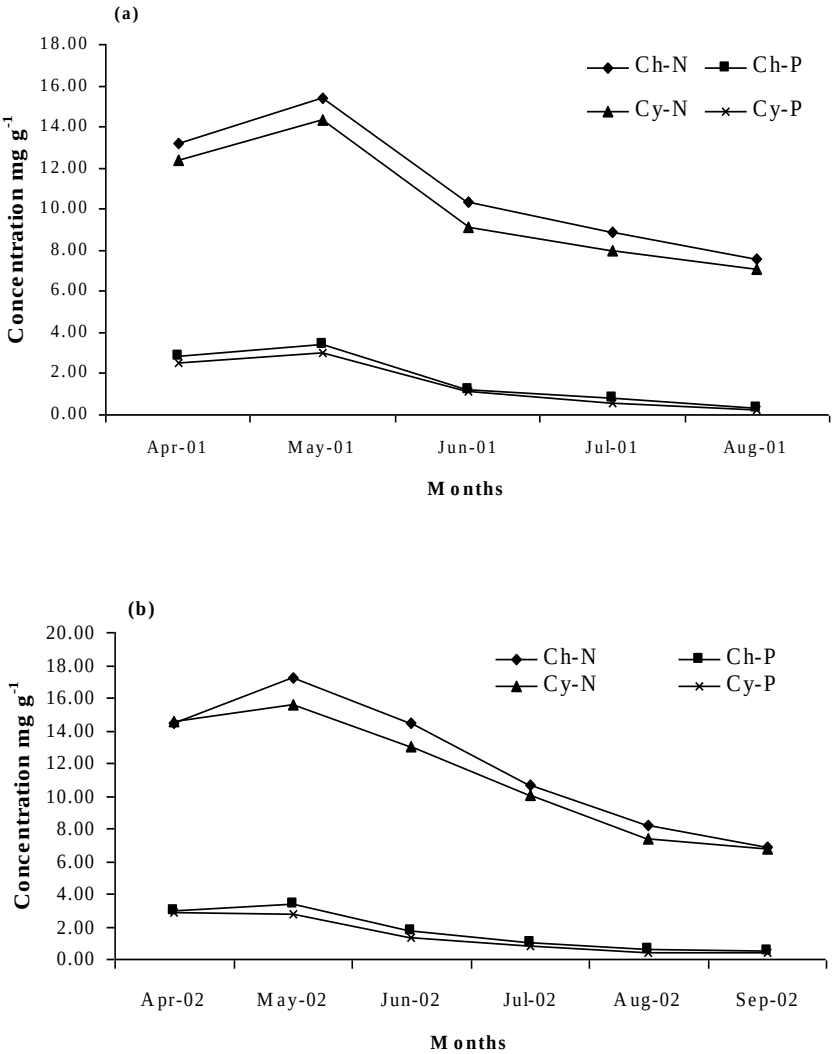

Fig. 1. Seasonal pattern of Nitrogen (N) and Phosphorus (P) mg g^{-1} in *Chrysopogon aucheri* (Ch) and *Cymbopogon jwarancusa* (Cy) during 2001 (a) and 2002 (b).

In both years, the phosphorus content of both species varied significantly within sampling dates and was significantly higher in early spring, then dropped and remained static for remainder of the year. In 2001, the concentration of P was significantly different ($p<0.05$) between months and non-significant differences were observed between species. In 2002, the concentration of P was significantly different ($p<0.05$) between months and significant differences were observed between species. In 2001, the concentration of P in spring and early summer was (1.1-3.4 mg g^{-1}) and least in late summer (0.26-0.81 mg g^{-1}) while in 2002 the concentration of P in spring and early summer was significantly higher (1.28-3.35 mg g^{-1}) and least (0.38-1.01 mg g^{-1}) in late summer (Fig. 1).

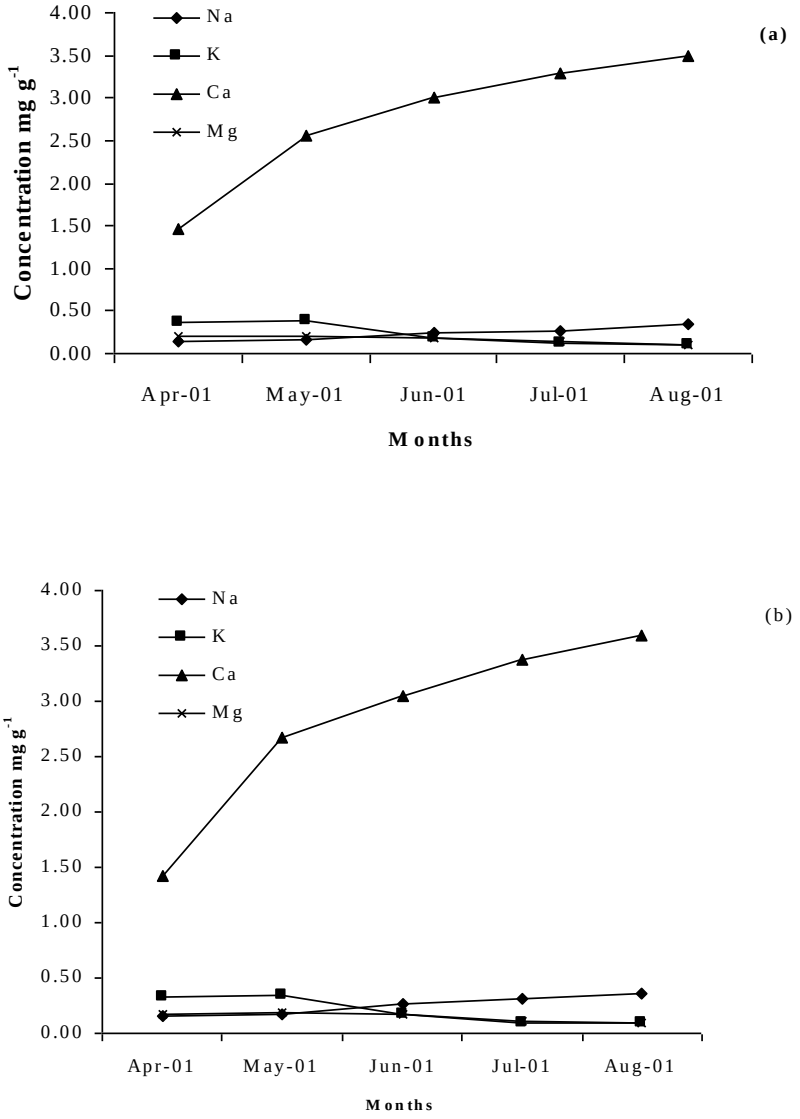

Fig. 2. Seasonal pattern of cations (a) *Chrysopogon aucheri* and (b) *Cymbopogon jwarancusa* during 2001.

In both grass species, there was a similar response of concentrations of K, Mg and Na and the concentration of these elements were higher during spring and then dropped and remained static for the remainder of the year while the concentration of Ca was lower in early spring and significantly ($p<0.05$) increased with the passage of time (Figs. 2, 3). During both the years, N: P ratios varied greatly with sampling. In both grasses the N:P ratio was below < 14 suggesting N-limitation during March and July and showed more than >16 during drier months of August and September.

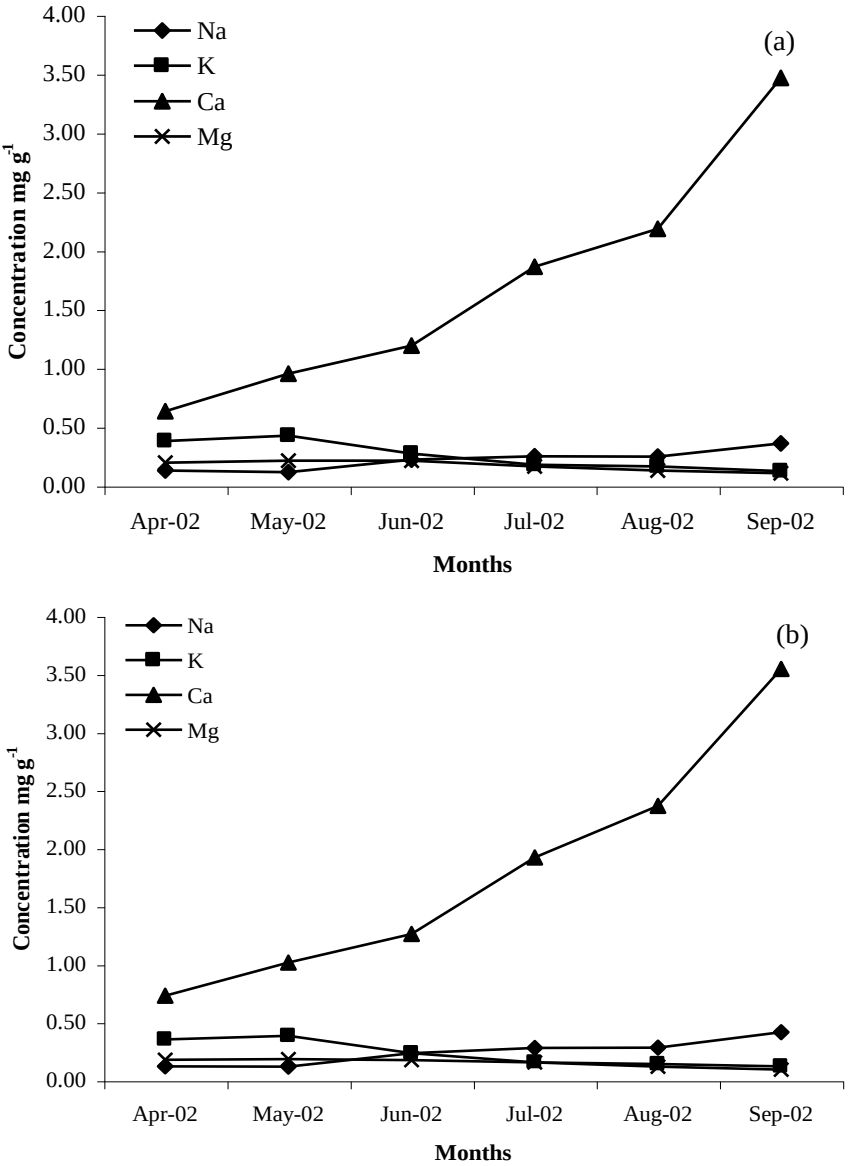

Fig. 3. Seasonal pattern of cations (a) *Chrysopogon aucheri* and (b) *Cymbopogon jwarancusa* during 2002.

The importance of grasses as a source of nutrients for grazing animals cannot be over emphasized in Balochistan where more than 93% of the land mass is considered rangelands. Nitrogen is the critical for both plant growth and animal nutrition and concentration of N in foliage of both grasses varied significantly among species and within years. Low nitrogen concentration of both the perennial grasses is a common trait of species with the C_4 pathway of carbon fixation (Brown, 1978). The preference of sheep and goat for *Chrysopogon aucheri* over *Cymbopogon jwarancusa* is due to its

better nutritional quality. The traditional approach is converting the concentration of total N to crude protein yields an over estimate of protein concentration in the leaves. Accordingly, during the springs of 2001 and 2002 in *Chrysopogon aucheri*, on dry wt basis it was estimated to be about 9-10% and 9-11% respectively and in the case of *Cymbopogon jwarancusa* 8-9% and 8-10% respectively. If we adopt 7.5% CP (Crude protein) level as an adequate forage quality threshold because it falls within the range of values suggested for maintenance of many wild and domestic herbivores (Anon., 1984) then these two grasses hardly fulfill the requirement of herbivores in late spring and summer.

Phosphorus concentrations in foliage declined with increasing plant maturity that has been linked with reduced voluntary feed intake (Ternouth, 1990). In dry months, low concentrations of P in foliage, are almost certainly related to the generally poor availability of phosphorus in dry soils (Simpson & Lipsett, 1973).

Calcium concentrations were much higher in both grasses and fulfilled the basic requirements 0.27% to 0.58% of ruminants (Anon., 1984). Ca: P ratios were usually more than 4:1 in summer in contrast to required ratios of 1:2 to 2:1 that are optimum for absorption of both minerals (Simesen, 1980) and may also affect the intake of grasses by ruminants. In both years the concentrations of K in perennial grasses were below the recommended 0.5-0.8% (Anon., 1984) minimum concentrations for ruminants. Magnesium concentrations were also low in both species as recommended minimum concentrations for ruminants is 0.12-0.18% (Anon., 1984).

Overall, both the native grass species were low in N, P and other nutrients except Na and Ca. Effective management strategies for ruminant grazing need at least a partial understanding of nutrient dynamics in available forages. Nutrient availability (such as N: P ratios) and to the quality of forages for stock (such as the Ca: P ratio) fluctuate markedly throughout the year. The results also suggest that grasses are N-limited during periods when they are actively growing and may appear slightly P-limited at other times.

These findings suggest that heavy but short-term grazing of Hazarganji grasslands after substantial rainfall may be one strategy to increase palatability and nutrition. Results of this study also indicate the need for direct, high quality mineral supplementation for grazing stock as also reported by Rahim *et al*., (2008), Sultan *et al*., (2008) for the nutritive value of marginal land grasses in the north Trans-Himalayan grasslands of Pakistan. .

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