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Research Article

Effects of Season on the Mineral (Potassium, Calcium, Phosphorus, Magnesium) Levels of *Pennisetum Pedicellatum* in Northern Ghana

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ABSTRACT

The aim of this study was to analyse the mineral (Phosphorus, Potassium, Calcium, and Magnesium) levels of *Pennisetum pedicellatum* in the wet and dry seasons. Purposive sampling was used to locate three different places where the grass was found. *Pennisetum pedicellatum* samples were harvested in both the wet and the dry seasons and analysed for their mineral levels. Magnesium and Calcium levels showed no significant difference (p>0.05) between the wet and dry seasons whiles Phosphorus and Potassium showed significant difference (p<0.05) between the wet and dry seasons. It was observed that the levels of Phosphorus, Potassium and Magnesium were higher in the wet season as compared to the dry season, except for Calcium which was high in the dry season. Since the levels of Phosphorus, Potassium and Magnesium were higher in the wet season and lower in the dry season, it is recommended that *Pennisetum pedicellatum* should be harvested in the wet season for feeding animals and hay preparation.

Keywords: *Pennisetum pedicellatum,* Seasons, minerals, Natural pastures,

INTRODUCTION

Natural pasture species are the main source of feed for livestock, and forms the major component of domesticated livestock feed in Ghana. However, monomodal distribution of rainfall, uneven seasonal growth and unavailability of pasture during certain times of the year have been considered as the major limitations to constant supply of forage in Northern Ghana. Even when forage is available they are in limited quantities and cannot maintain the animal feed throughout the year. The low quality of grasses during some period of the year is reflected in low production and reproductive performance, as well as slow growth in ruminants (Mafwere and Mtenga 1990; Ndemanisho *et al.,* 1998; Kakengi *et al.,* 2001).

One of the major concerns of ruminant keepers is the strategic provision of feed to meeting the nutrient requirements of the livestock. In the traditional setting, this demand by the animals is presumptuously met through the basal supply of natural pasture grass. Unlike concentrates, the chemical composition (nutritive value) of forages varies with physiological age, time of grazing or harvest, species and botanical fraction (Tainton, 2000).

According to Newman *et al.* (2009), weather conditions and forage maturity are the primary factors affecting quality of a stand. Maturity or stage of growth is the principal factor responsible for declining forage nutritive value. As the plant advances in growth beyond the first couple of weeks (where protein and digestibility are highest), stem growth advances, as well as deposition of fibrous components at the plant cell level. If the forage is too mature, fibre is more prevalent in the forage, and digestibility of the forage declines; crude protein (CP) also declines in the forage tissue. This decline is more pronounced and sudden in warm-season perennial grasses especially in plant tissue older than 35-40 days.

Other factors affecting forage quality are fertilization, season, pre- and post-harvest management, and presence of anti-quality factors. Concentrations of mineral elements in forage are dependent upon the interaction of a number of factors, including soil, plant species, and stage of maturity, pasture management and climate (McDowell *et al*., 1983). When mineral nutrients in herbage are marginal in respect of animal requirements, changes in concentrations brought about by climatic, managerial or seasonal influences and plant maturity are significant factors in incidence of deficiency state in livestock which wholly or largely depend on plants (Underwood, 1981). Drought stress is one of the major factors for the reduction in agricultural productivity in the majority of regions of the world, particularly in the arid and semi- arid regions (Boyer, 1982; Ashraf, 1994; Bajaj *et al.,* 1999). It is now known that extent of drought tolerance varies from species to species in almost all plant species (Lin *et al.,* 2006). Although, the general effects of drought on plant growth are quite well known, the primary effects of water deficit at the biochemical and molecular levels are not well understood (Chaves *et al.,* 2003, Zivcak *et al.,* 2008; Jaleel *et al.,* 2008). The effect of seasonal changes on forage may be more serious because the soil is drier during the summer and more fertile during the wet season. In the absence of mineral supplements, forage should contain sufficient macro and micro elements essential for growth and reproduction of livestock and other grazing animals. Otherwise, the animals are greatly affected, that is, disorders in livestock production are mainly due to naturally occurring deficiency of one or more of the essential elements in forage (Masters, *et al*., 1993)

Much knowledge into the mineral element content of the grass *Pennisetum pedicellatum* in their natural environment in Ghana is not available, even though they serve as a major feed component of livestock in Northern Ghana. This research aimed at establishing the effect of dry and wet seasons on the mineral levels of *Pennisetum pedicellatum*.

MATERIALS AND METHODS

Study Area

The study was conducted at the Nyankpala campus of the University for Development Studies. Nyankpala falls under the Tolon-Kumbungu District of the Northern Region of Ghana within the Guinea Savannah Agro-ecological zone. Geographically, the district lies within latitude 9°25'N and longitude 0°58'W. Nyankpala is 16km (10miles) away from Tamale, the capital of the region with an altitude of 183m above sea level. The study area has an annual rainfall of 1034mm distributed fairly from April to late November with a mean monthly temperature of 22°C. Relative humidity in the study area is at its maximum during the rainy season with monthly value of 80% and a sharp decrease to a minimum monthly value of 53% during the dry season (SARI, 2005).

The vegetation is typically grassland. Common trees found include *Azadirachta indica, Parkia biglobosa, Adansonia digitata, Tectona grandis,* and *Sena siamea*. Common grasses include *Pennisetum pedicellatum, Andropogon gayanus, Sporobolus pyramidalis, Setaria pallid-fusca* and *Panicum maximum.* The people of the area are mostly farmers growing crops like maize, rice, sorghum, millet, yam, ground nut and soya beans and mainly practice the free range (extensive) system of livestock farming.

Sampling method

Purposive sampling was used to select three sites where these grasses were growing naturally and they were protected throughout the wet and the dry seasons. Each of the three protected sites was divided into two and half of each plot was harvested in the wet season. The other half from each plot was also harvested in the dry season. The grasses were cut 8cm from the base of the plants during the harvesting. The samples collected were dried for two weeks in both cases and pulverized.

Laboratory analysis of P, K, Ca, and Mg

The powdered samples were weighed into digesting tubes, placed on a block digester to heat to a temperature of 360^{o}c for 4 hours by which time the digested samples solution looked colourless and clean, it was then transferred into a 100ml volumetric flask and topped to the mark. This solution contains: P, K, Ca and Mg. The potassium concentration was then measured using a flame photometer whiles calcium and Magnesium were determined directly using an Atomic Absorption Spectrophotometer (AAS).
The phosphorus blue colour was developed using Molybdate, Ascorbic acid and a sample solution derived from the previous laboratory analysis for K, Ca, and Mg. The blue colour intensity was then measured on the ultra violet visible spectrophotometer.

Data analysis

The data collected from the various samples during laboratory tests were subjected to t- test using Microsoft Office Excel to determine whether significant difference existed in the level of the mineral nutrients recorded between the seasons.

RESULTS AND DISCUSSION

Levels of Minerals in *Pennisetum Pedicellatum* in the Wet and Dry Seasons

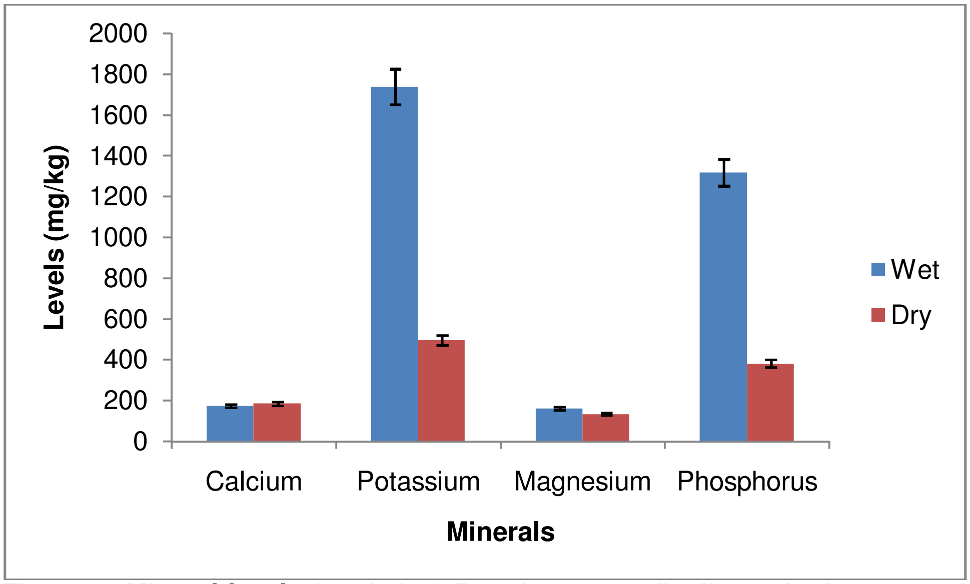

Figure 1: Mineral levels (mg/kg) of *Pennisetum pedicellatum* in the wet and the dry seasons.

Level of Magnesium in *Pennisetum pedicellatum*

The mean level of Magnesium in *Pennisetum pedicellatum* was found to be 160.6 mg/kg in the wet season and 133 mg/kg in the dry season. There was no significant difference (p>0.05) in the levels of Magnesium in both seasons though in nominal terms Magnesium level was higher in the wet season than in the dry season. The decrease in Magnesium level of the *Pennisetum pedicellatum* in the dry season could be attributed to the fact that in the dry season competing cations in the soil such as Ca^{2+}, H^{+}, NH_4^{2+}, Al^{3+} and Na^{+} prevent Magnesium intake by the plant. This agrees with Mengel and Kirkby (2001) and Shaul (2002), who stated that Magnesium deficiency in plants can be induced, however, not only by direct lack of Magnesium but also by the presence of competing cations that prevent Magnesium uptake by plants. It could also be as a result of the fact that Magnesium content of plants are highly used in the growing of root in the dry season so that it can absorb all available water and nutrients in the soil during the dry season where there is water stress on the plant. This in turn reduced the amount of Magnesium content in the above ground part of the plant in the dry season. This is in line with the findings of Ejaz *et al.* (2011), which state that Magnesium increases the root growth and root surface area, which helps to increase uptake of water and nutrients by roots and transport of sucrose from leaves to roots. This comes to confirm a similar work done by Orden *et al.* (1998), which state that Magnesium level in *Pennisetum Purpurum* decreased from a critical value of 0.18% in the wet season to 0.16% in the dry season.

Level of Calcium in *Pennisetum pedicellatum*

The mean level of Calcium in *Pennisetum pedicellatum* was lower in the wet season but higher in the dry season. However, statistically, there was no significant difference (p>0.05) between the two seasons even though the nominal values showed that calcium level was higher in the dry season than in the wet season. The increase in the calcium level in the *Pennisetum pedicellatum* in the water stress period (dry season) could be that the plant accumulated the Calcium to deal with all injuries which happen as a result of the water stress. This is in conformity with Ejaz *et al.* (2011), who said that the possible mechanism to minimize detrimental effect of drought in crop plants is that, the Calcium level in the plant be improved.

Moreover, plant loose nutrients when there is damage to its cell due to injury caused by changes in season. Therefore Calcium is produced more to help the plant to survive during injury and recovery from injury in the dry season. This accounted for the high calcium level in the dry season. This is in line with Palta, (2000), who states that

Calcium is considered to play a role in mediating stress response during injury, recovery from injury and acclimation to stress. Similar study done by Orden *et al.* (1998), show that Calcium in *Centrosema pubescens* increases from 0.67% in the wet season to 0.70% in the dry season and in *Mimosa pudica,* from 0.87% in the wet season to 0.91% in the dry season.

Level of Potassium in *Pennisetum pedicellatum*

The mean level of Potassium in the wet season in nominal terms was much higher than in the dry season. This showed a significant difference ($p<0.05$) in the Potassium levels between the two seasons. The decrease in Potassium level in the dry season could be due to the excessive use of K by the plant in the dry season to carry out its physiological processes. This agrees with Ejaz *et al.* (2011), who said that Potassium plays an important role in the survival of plants under stress conditions. Also Marschner (1995); Mengel and Kirkby (2001) state that Potassium is essential for many physiological processes such as photosynthesis, translocation of photosynthesis into sink organs, maintenance of turgescence, activation of enzymes. It further conforms to Cakmak and Engels, (1999) that there is increasing evidence that plants suffering from environmental stress like drought have a larger internal requirement for Potassium.

Again, Potassium is an important nutrient and plays an essential role in water retention, osmotic adjustment, stomatal movement and plant resistance to drought. The reduction in potassium content in the *Pennisetum pedicellatum* in the dry season could be attributed to the fact that there was water deficit in the soil during the dry season. This agrees with Seyed *et al.* (2011) that the reduction in Potassium content is as a result of damage caused to the membrane and disruption in ion homeostasis.

Level of Phosphorus in *Pennisetum pedicellatum*

The research also revealed that the mean level of Phosphorus in *Pennisetum pedicellatum* in the wet season was much higher than in the dry season. It was observed that the Phosphorus level in the wet season was significantly higher ($p<0.05$) than in the dry season. The decreased in Phosphorus level in the dry season could be attributed to the dryness of the soil because Phosphorus in the soil is not made available to the root of the plant for uptake. The roots cannot absorb the Phosphorus in the solid form, but it is able to absorb in the liquid form. This renders plant incapable to accumulate Phosphorus in the dry season. This agrees with Havlin *et al.* (2007), that, Phosphorus is found less in quantity in dry soils. Total Phosphorus in soils varies from 0.005 - 0.15%. Bagayoko *et al,* (2000), also state that an important approach to increase Phosphorus uptake in plants involves taking advantage of the symbiosis between the root and mycorrhizae. Moreover, Ejaz *et al.* (2011) concluded that Phosphate levels may be low in plants in the dry season due to the dry soil conditions or impaired root uptake.

CONCLUSION

The research revealed a higher level of Magnesium in *Pennisetum pedicellatum* in the wet season than in the dry season but there was no significant difference between the two seasons statistically. It has been established per this work also that the Phosphorus and Potassium levels in *Pennisetum pedicellatum* were significantly higher in the wet season than in the dry season. However, Calcium level in *Pennisetum pedicellatum* in the wet season was lower than in the dry season but there was no significant difference between the two seasons. It can therefore be concluded that changes in season have much significant impact on the levels of phosphorus and Potassium in *Pennisetum pedicellatum* grass in the Guinea Savanna ecological zone of Ghana. It is therefore recommended that livestock farmers and hay/forage producers should harvest *Pennisetum pedicellatum* in the wet season during which levels of the minerals are high for animal consumption.

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