THE EFFECTS OF FERTILIZATION ON NUTRIENT CONTENT OF PASTURE, SOIL AND WATER IN 3 SAVANNAHS AT DISNEY'S ANIMAL KINGDOM LODGE

Kathleen E. Sullivan, MS, and Eduardo V. Valdes PhD*

Disney's Animal Kingdom, PO Box 10000, Lake Buena Vista, FL 32830 USA

Abstract

Historically, grass nutrient content at Disney's Animal Kingdom Lodge (DAKL) has been observed to have high levels of potassium (> 4 %), a possible concerning factor in the development of hypomagnesemia in grazing hoofstock. There had been no fertilization of the savannahs at DAKL for 2 years prior to the current study, and potassium levels had reduced approximately by half (~ 2 %). In order to test the effects of fertilization on the grass nutrient content, water nutrient content and soil nutrient content at DAKL, a year long study was initiated. Two specific areas of each of the 3 savannahs with animals present at DAKL were fertilized in May 2008 with Nature Safe 8-3-5 Stress Guard Fertilizer (Griffin Industries, Cold Spring, KY). A pre-fertilization sample was also taken in both in the areas to remain unfertilized and each of 6 areas to be fertilized. Sampling began June 2008 on a monthly basis of all fertilized areas, unfertilized controls, and an unfertilized control without animal presence. Water and soil samples were also taken. Based on concerns of hypomagnesaemia and laminitis, the nutrients of most interest were magnesium, potassium, starch, sugars and soluble carbohydrates. In all cases, there were minimal to no significant differences in the grass content between fertilized areas and unfertilized areas in terms of these nutrients. There appeared to be some seasonal variation in the grass with potassium and magnesium lower during the winter months of January and February. Starch, sugar and soluble fiber did not show any clear patterns throughout the year. Potassium and magnesium levels in the water appeared to be low and steady throughout the year, with total dissolved solids slightly elevated in the first two months after fertilization but still within normal parameters. Soil samples also did not differ in nutrient content across time or by area. The lack of differences in nutrient content with fertilization indicates that the addition of mineral nutrients through the fertilizer used may not be directly responsible for changes in grass nutrient content.

Introduction

The savannahs at Disney's Animal Kingdom Lodge contain a variety of hoofstock species including zebra, giraffe, kudu, blesbok, nyala, sable, roan antelope, wildebeest and ankole cattle, as well as bird species such as east African crowned cranes and ostriches. Many of the antelope species, monitored by serum analysis, as well as through health related incidences have been found to have low serum magnesium in recent history (hypomagnesemia).[3] While the causation for this condition in these species may be due to multiple factors, investigation into the nutrient content of the grass, found levels of > 4 % potassium (K). These would be considered levels of K on the upper end of normal, and unexpectedly high for grass savannah.[5] Levels this high are associated with a doubling of the magnesium requirement for ruminant species.[5] Due to concerns about fertilizer contributing potassium to the grasses, fertilization was halted for 2 years

prior to the current study. Potassium levels in the grass over the course of those two years gradually went down to ~ 2 %.

This study was performed to test the nutritional influence of a potassium containing fertilizer when reintroduced to the savannahs in limited quantity. Due to the influence of fertilizer on soil, as well as the influence of irrigation on the grasses, both water and soil nutrient contents were also monitored.

Materials and Methods

Two marked plots in each of 3 savannahs (Uzima, Arusha, Sunset) were fertilized in May 2008 (6 total) with Nature's Safe 8-3-5 Stress Guard Fertilizer (Table 1). This fertilizer was used on DAKL savannahs in previous years. An additional set of plots were kept unfertilized as a control (3 total). A pre- fertilization sample was taken in April of 2008 in each savannah, both in the unfertilized and fertilized plots. Sampling was done monthly for one year starting June 2008. Two samples were taken in each fertilized plot (12 fertilized samples / month) and two samples were taken in the unfertilized plot of each savannah (6 unfertilized samples / month). A sample was also taken once monthly from a fourth savannah (Pembe) which remained unfertilized and without any animals present as a separate control. Animals remained on all savannahs except Pembe through the duration of the study.

Grass samples taken with a hedge cutter or hand shears, with care taken to avoid soil contamination of the samples. All grass samples were taken back to the nutrition center in a cooler and immediately processed. Leaves and other non grass items were removed by hand from the sample while weighing into aluminum pans and tested for dry matter. After consistent dryness was achieved the samples were sent to Dairy One Forage Laboratory, Ithaca, NY for proximate composition analysis, including protein, fat, minerals, starch and sugar. Soil samples were taken with a metal soil sampler (Seedboro Equipment Co. Chicago IL) and analyzed via X-ray fluorescence for qualitative mineral content. Water samples were taken from irrigation heads on each savannah (3 samples / month) and also sent to Dairy One for complete analysis including dissolved solids, nitrates, sulfates, pH, hardness, calcium, phosphorus, K, magnesium, sodium, iron, zinc and copper.

All variables for grass nutrients were analyzed using two-way ANOVA in JMP (SAS Institute Inc., Cary NC) and compared against each other and Pembe, as well as within savannahs by month. Comparisons were considered significant when $p < 0.05$.

Results

There were few significant differences between savannahs, or within savannahs over the course of the year. Mineral content, crude protein, and carbohydrates were similar between each of the two fertilized areas and one unfertilized area for each savannah. Crude protein did not significantly differ based on fertilization treatment, although the unfertilized savannah with no animals on it (Pembe) was significantly lower (~6% on average versus approximately 12% in all other sampling areas throughout the year). Potassium and magnesium in the savannah grasses were significantly lower during the winter months of January and February in Arusha and

Uzima, and only for the month of January in Sunset (Figure 1). Starch, sugar and soluble fiber did not show any clear patterns throughout the year. Uzima and Arusha were lower on average than Sunset and Pembe in terms of starch, with sugar levels similar across savannahs. Average levels of nonstructural or soluble carbohydrates (starch and sugars) varied throughout the year both with and without fertilizer, ranging from 2 – 8.5 % (Figure 2). Potassium (Figure 3) and magnesium levels in the water appeared to be low and steady throughout the year, with total dissolved solids slightly elevated in the first two months after fertilization but still within normal parameters, Soil samples also did not appear to differ in nutrient content across time or by area based on a qualitative analysis.

Discussion

The lack of differences in nutrient content between controls and fertilized pasture indicates that the addition of minerals through the fertilizer used may not be directly responsible for changes in grass nutrient content. Carbohydrates in the grasses did not appear linked to fertilization. The change in range of soluble carbohydrates should continue to be monitored as high levels in the diet have been linked with laminitis.[4] In the future we will be monitoring water soluble carbohydrates including fructans through direct analysis.

Other factors which may influence the K levels in the grasses may be environmental. Also, the variability in potassium content in animal urine influenced by differences in diet, temperature, and physiology between animals may be a factor, as urinary K is ionized, water soluble and readily available for plant uptake.[1, 2] The levels of irrigation may also effect the leaching of minerals from the grass and soil.[2] We were able to measure only water from the irrigation heads rather than any possible runoff. Further investigation is needed to understand why potassium decreased in the grasses when the only marked change was a lack of fertilizer, but did not increase against controls when fertilizer was reintroduced.

Acknowledgements

The authors would like to thank the Disney's Animal Kingdom Lodge animal care team, especially Liesl King, for all of the help with intensive sampling, and great teamwork on this study. The authors would also like to thank the Disney Horticulture team for helping us with fertilization, and Dr. Lisa Hoopes for editing feedback and statistical analysis help.

LITERATURE CITED

1. Haynes R.J. and Williams P.H. 1993. Nutrient cycling and soil fertility in the grazed pasture ecosystem. Advances in Agronomy 49:119 – 199.
2. Kayser M. and J. Isselstein. 2005. Potassium cycling and losses in grassland systems: a review. Grass and Forage Science 60:213 – 224.
3. Miller M., Weber M., Valdes E., Fontenot D., Neiffer D., Robbins P.K., Terrell S., Stetter M. 2003. Hypomagnesemia, hypocalcemia, and rumenitis in ungulates: an under-recognized syndrome? In: American Association of Zoological Veterinarians Annual Proceedings. Minneapolis, MN Pp. 15-20.

4. National Research Council. 2007. Nutritional Requirements of Horses 6th revised edition. National Academies Press, Pp. 248 – 250.
5. Underwood E.J., and Suttle N.J. 1999. The Mineral Nutrition of Livestock, 3rd ed. CABI Publishing, New York, NY Pp. 213 -227.

Table 1. Guaranteed Analysis of Nature Safe 8-3-5 Stress Guard Fertilizer (Griffin Industries, Cold Spring, Kentucky)

Guaranteed Analysis	%
Total Nitrogen (N)	8
Available Phosphate (P2O5)	3
Soluble Potash (K2O)	5
Magnesium (H2O Soluble Mg)	2.2
Sulfur (Combined S)	4

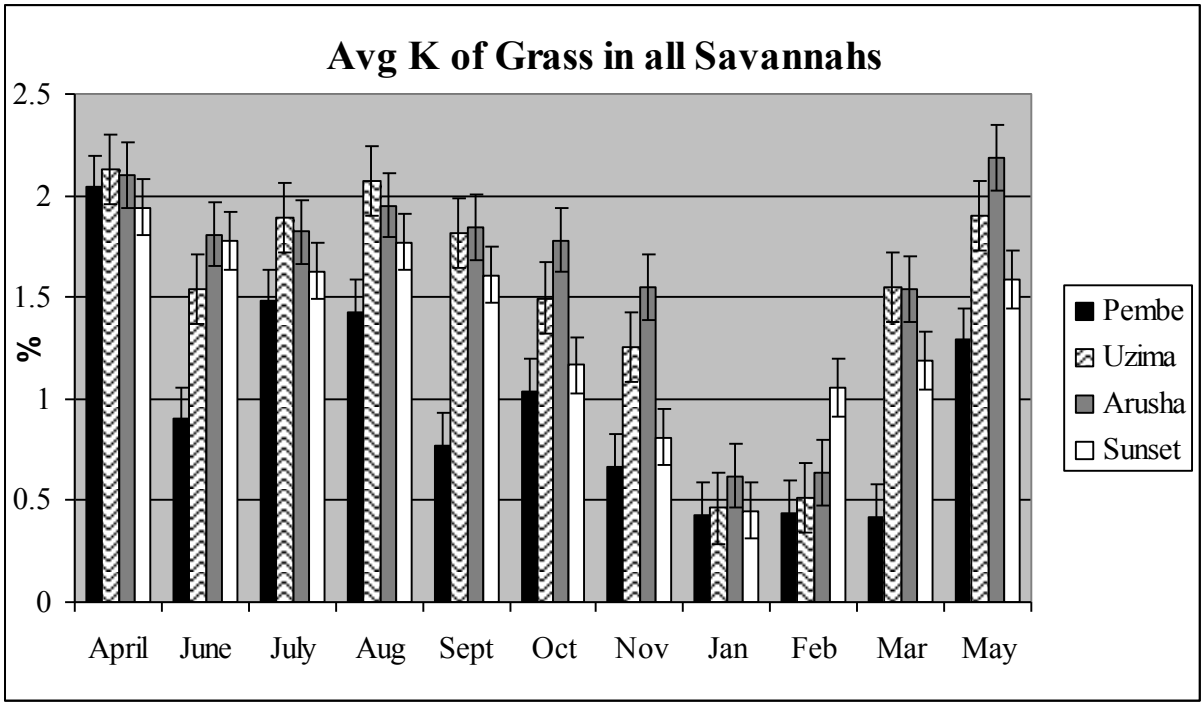

Figure 1. Average potassium content of analyzed grass samples of 4 different savannahs at Disney's Animal Kingdom Lodge from April 2008 to May of 2009.

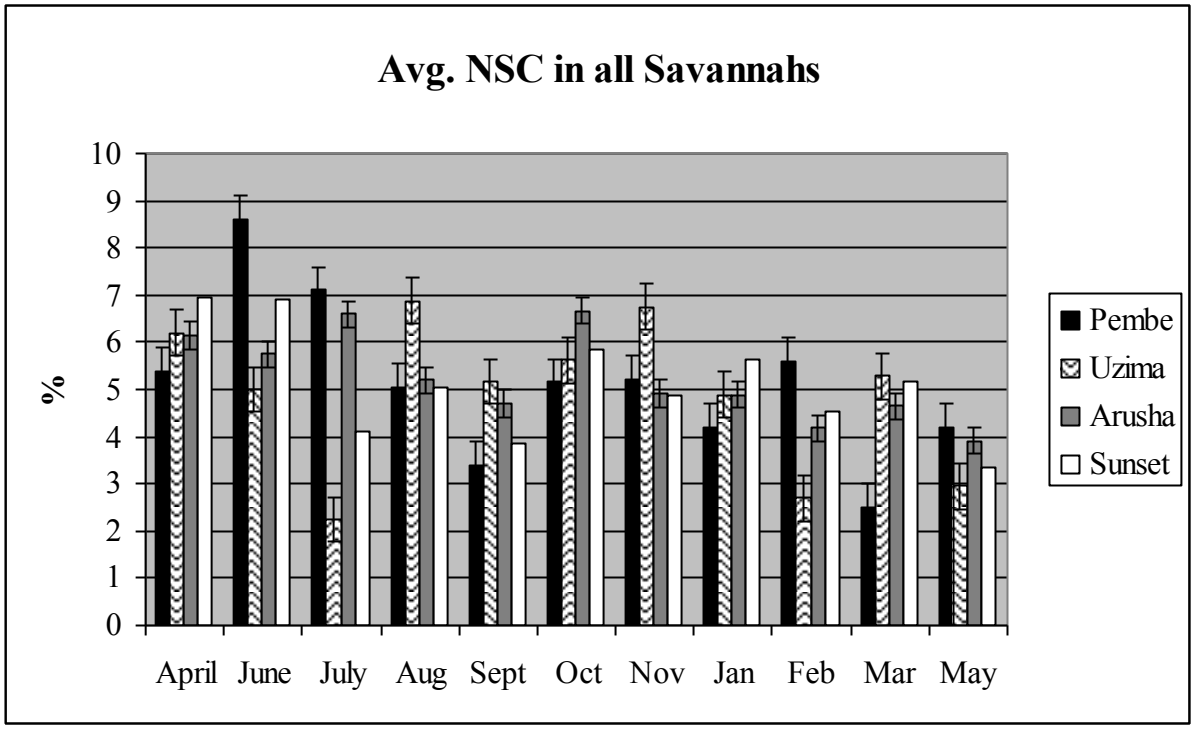

Figure 2. Average Non-Structural Carbohydrate (NSC – includes starch + sugars) content of analyzed grass samples of 4 different savannahs at Disney's Animal Kingdom Lodge from April 2008 to May of 2009.

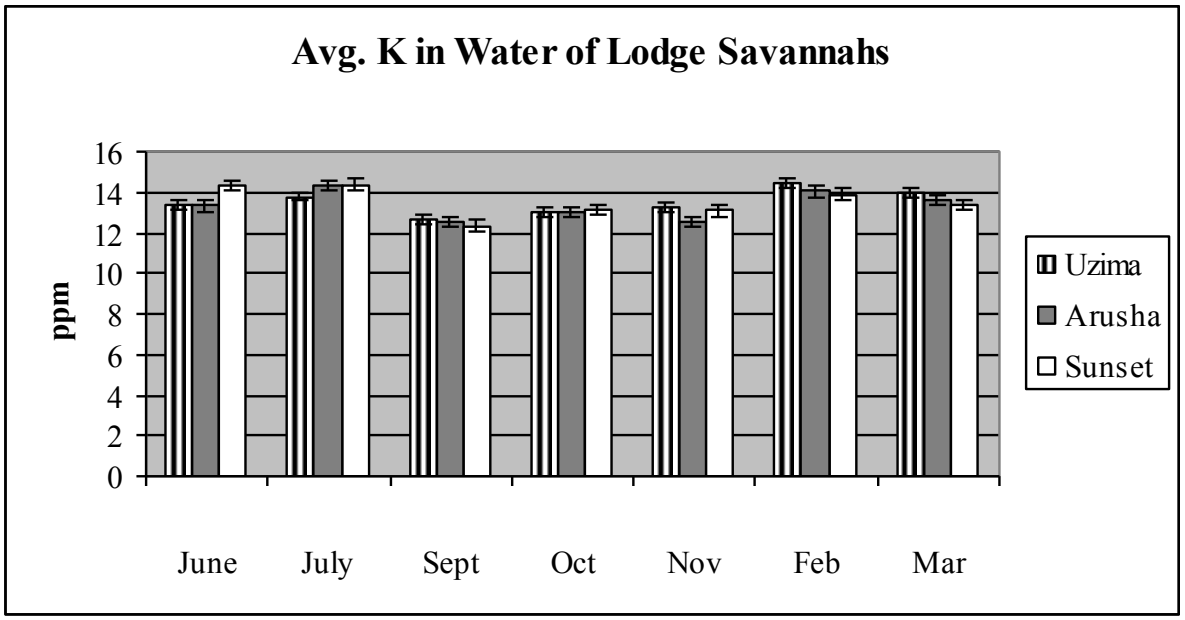

Figure 3. Average potassium content of analyzed water samples of 3 different savannahs at Disney's Animal Kingdom Lodge from June 2008 to March of 2009.