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RESEARCH ARTICLE

Effect of seasonal changes on the herbage composition of *Stylosanthes hamata* Taub cv. Verano and *Centrosema pascuorum* Mart. Ex. Benth in the Nigerian sub-humid zone

Omoregie, A.U[1]., and Nwajei, S.E[*2]

[1]Department of Crop Science, Ambrose Alli University, Ekpoma, Nigeria
[2]Department of Agroecology and Applied Ecology, University of South Bohemia, Czech Republic.

Edited by:

Dr K. Ashokkumar,
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Reviewed by:

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*Corresponding author e-mail address: nwajes00@jcu.cz (Nwajei, S.E).

ABSTRACT

The study conducted in the Nigerian sub-humid zone aimed to investigate the impact of seasonal changes on the crude protein and mineral composition of verano stylo and centro, two types of forages. Plant samples were collected from September in the establishment year (wet season) through July in the succeeding year (dry season) for analysis. The findings revealed that the herbage had the highest crude protein (CP) and mineral contents during the wet season compared to the dry season. Specifically, centro exhibited a more significant difference in CP content between seasons, being lower than that of verano during the dry season. Phosphorus (P) concentration showed no significant difference during the dry season, but Centro had considerably higher P levels during the rainy season. The study noted variability in micro-nutrient content in the forages across seasons. Crude protein, phosphorus, and copper were identified as the most limiting nutrients, particularly in the dry season, based on recommended critical level requirements. This implies that feed supplementation would be necessary to address these nutrient limitations and improve animal production in the zone, especially during the dry season. In summary, the study highlights the seasonal variations in herbage composition, emphasizing the importance of understanding nutrient content fluctuations for effective livestock management in the Nigerian sub-humid zone. It suggests that implementing feed supplementation strategies, particularly addressing the limitations in crude protein, phosphorus, and copper, could contribute to enhanced animal production, particularly during the dry season.

Keywords: Centro, *Centrosema pascuorum,* Crude protein, *Stylosanthes hamate,* Herbage, Mineral composition

INTRODUCTION

The sub-humid zone (SHZ) of Nigeria, covering approximately 50% (455,000 sq km) of the country's land mass, plays a crucial role in supporting livestock populations (Bourn and Miligan, 1984). With a growing season lasting between 180 and 270 days, this zone has the potential to sustain increased livestock numbers and enhance productivity per animal (Von Kaufmam, 1986; Mohamed-Saleem and Suleiman, 1986).

The SHZ is characterized by savanna grasses, interspersed with shrubs and scattered trees. It experiences two distinct seasons – the rainy season from May to mid-October and the dry season from mid-October to April. During the rainy season, forages, primarily native grasses, are abundant but may vary in quality. However, challenges arise in the dry season due to insufficient pasture supply, leading to a north-south movement in search of forages (Omoregie and Oshineye, 2002; Omoregie, 2015; Omoregie, & Omueti, 2022). To address the dry season feed quality issues in the zone, the National Animal Production Research Institute (NAPRI), Shika, Zaria, and the sub-humid zone program of the now International Research Institute (ILRI), Addis Ababa (formerly International Livestock Centre for Africa, ILCA), conducted extensive evaluation work on the adaptability of tropical forages. *S. hamata cv. verano* and *C. pascuorum* are among the proven species identified.

Recognizing the wide variation in herbage mineral concentrations among species, growth stages, and plant parts, which are crucial factors in selective grazing (Kim, 2001; Hacker, 1982; Omoregie and Aken Ova, 2000), the objective of the study was to evaluate the protein and mineral profiles of the two proven forage legumes in pastures within the SHZ of Nigeria. The study aimed to provide insights that could guide improvements in ruminants' nutrition planning in the region, taking into account seasonal variations. The results obtained from this study are anticipated to contribute valuable information for enhancing livestock management practices and addressing nutritional challenges in the sub-humid zone.

MATERIALS AND METHODS

The field experiments were conducted at three locations in the Nigerian Sub-Humid Zone (SHZ): Kurmin Biri, Kontagora, and Shika, Zaria. Each location had an area measuring 40x20m, cleared of vegetation and fenced to prevent free-grazing livestock. The soil was prepared manually to fine-tilth using hoes. Forty plots, each measuring 3mx3m with 0.6m pathways, were established at each location.

The experiment followed a factorial design with two factors: two legumes (Verano stylo and *C. pascuorum* or centro) and five levels of phosphorus (P) (0, 20, 40, 60, and 80kg/ha), with a single superphosphate as the P source. The ten treatment combinations were replicated four times and arranged in a randomized complete block layout.

Additional nutrients such as potassium (K) as KCl, sulfur (S) as Na_2SO_4, magnesium (Mg) as MgCl, and calcium (Ca) as $CaCO_3$ were applied at specific rates per plot during land preparation. The fertilizers were evenly broadcast on the soil surface. Scarified seeds of Verano stylo and centro were sown by broadcasting at 10kg/ha in June.

Plant samples were collected between September in the establishment year and July the following year, covering both wet and dry seasons. The crude protein and mineral composition of the plant materials, obtained 2 cm above the soil surface using 0.3x0.3m quadrants, were analyzed following the method outlined by AOAC (2002). The data on mineral composition were subjected to statistical analysis, and the standard error was calculated using Statistical Package for Social Sciences version 23.

This experimental setup aimed to assess the impact of legume type and phosphorus levels on the forage's crude protein and mineral composition across different seasons in the Nigerian SHZ. The results obtained from this study are expected to contribute valuable insights into optimizing nutrient management for improved forage quality in the region.

RESULTS AND DISCUSSION

The study indicates that locational differences in soil contents are reflected in the crude protein (CP) and mineral contents of Verano stylo and centro, two legumes evaluated in the Sub-Humid Zone (SHZ) of Nigeria (**Table 1**).

The concentrations of micro-nutrients in the forages were found to be variable with the season (**Table 2**).

Table 1. Physical and Chemical Properties of Soils Used for the study

Location/ Horizon	Sand	Silt	Clay	Texture Class	pH H_2O	$CaC1_2$	Organic Carbon	Total N	Exchangeable Mg	Ca	Na	K	Acidity	ECEC	BS	Available P	Cu	Zn	Fe_2O_3	$A1_2O_3$
	← g/kg →						← g/kg →		← cmol/kg →						%	← % →				
Kurmin Biri																				
0 – 20	608	192	200	Sandy loam	5.8	5.3	6.7	0.6	1.42	1.85	0.22	0.56	0.20	4.25	96.29	4.50	0.06	0.72	0.74	0.12
20 – 60	528	212	260	Sandy loam	5.7	5.3	3.3	0.3	1.42	0.80	0.23	0.20	0.40	3.05	86.88	1.42	0.05	0.32	ND[1]	ND
Kontagora																				
0 – 20	628	312	60	Sandy loam	6.5	6.2	9.1	0.6	2.67	2.20	0.23	0.23	0.20	5.53	96.4	5.35	0.01	0.49	0.34	0.18
20 – 60	528	352	120	Sandy loam	6.1	6.0	1.2	0.4	3.83	1.10	0.02	0.16	0.40	5.59	92.97	0.51	0.01	0.33	ND	ND
Shika																				
0 – 20	788	132	80	Sand	6.3	6.0	6.0	0.6	2.71	5.32	0.31	0.57	0,20	9.12	97.89	8.00	0.05	0.90	0.94	2.84
20 – 60	848	920	60	Sand	6.0	5.3	4.5	0.5	2.08	3.35	0.24	0.21	0.40	6.28	93.63	1.35	0.09	0.27	ND	ND

Note, CEC= Effective cation exchange capacity

BS= Base saturation

ND= Not determined

Table 2. Effect of seasonal change on composition of Verano Stylo and Centro in the SHZ.

Location/ Month	Verano stylo									Centro								
	Cp	P	K	Mg	Ca	Mn	Fe	Cu	Zn	Cp	P	K	Mg	Ca	Mn	Fe	Cu	Zn
	← % DM →					← mg/kgDM →				← % DM →					← mg/kgDM →			
Kurmin Biri																		
September	14.31	0.14	1.86	0.33	1.91	174.12	180.90	7.14	30.94	14.26	0.09	1.67	0.22	1.68	126.90	148.24	6.08	32.78
November	11.81	0.08	1.45	0.20	1.45	135.48	101.28	28.20	11.38	0.08	0.08	1.53	0.24	1.57	111.90	118.24	5.42	24.78
February	8.31	0.04	2.32	0.41	2.29	173.18	198.28	7.04	36.18	5.00	0.04	2.20	0.43	2.70	180.84	241.92	6.72	43.04
March	4.50	0.03	1.01	0.22	1.67	139.94	250.52	4.72	16.12	4.31	0.03	1.03	0.77	1.17	76.06	193.96	3.58	18.32
April	4.25	0.02	1.57	0.22	1.48	77.20	193.86	5.38	23.45	4.06	0.02	1.15	0.33	1.90	136.20	202.44	6.04	12.40
May	7.88	0.02	0.23	0.21	1.59	146.62	166.64	3.08	20.80	6.88	0.03	0.02	0.24	1.70	260.28	278.66	7.88	21.56
June	13.31	0.09	1.61	0.32	1.90	204.42	127.38	7.32	54.84	16.04	0.10	1.78	0.28	1.76	190.00	148.52	9.52	51.86
July	13.50	0.12	1.60	0.29	1.75	198.14	167.04	10.36	56.5	12.38	0.15	1.72	0.26	1.86	170.20	148.52	12.12	51.94
SE	1.43	0.02	0.22	0.27	0.10	14.47	16.0	2.83	5.99	2.01	0.02	0.24	0.78	0.15	20.01	19.30	0.94	5.42
Kontagora																		
September	14.50	0.08	1.75	0.41	1.96	91.94	195.40	5.64	52.22	14.19	0.09	1.76	0.28	2.00	74.26	172.46	4.98	49.70
November	9.31	0.08	2.16	0.38	2.27	140.30	153.18	6.36	49.74	10.31	0.09	2.28	0.43	2.19	121.17	149.46	7.05	71.72
February	4.91	0.03	2.22	0.37	2.84	139.54	298.34	4.38	74.04	5.00	0.04	2.20	0.43	2.61	180.34	241.92	6.72	43.04
March	3.86	0.03	1.21	0.11	0.92	14.32	109.22	1.54	29.28	4.50	0.03	1.13	0.23	2.04	96.80	260.98	3.38	38.85
April	4.06	0.02	1.14	0.14	1.05	40.56	122.54	3.56	24.64	4.50	0.03	1.37	0.32	1.54	108.50	139.16	4.28	15.88
May	6.25	0.04	0.23	0.18	1.68	89.18	370.84	4.40	55.04	4.50	0.04	0.16	0.18	1.49	106.94	236.22	3.96	64.46
June	12.31	0.14	1.85	0.37	1.64	115.26	142.30	8.90	88.04	16.38	0.18	2.05	0.29	1.96	141.56	181.34	9.10	56.92
July	11.44	0.11	1.61	0.38	1.81	114.10	191.46	7.52	41.36	14.69	0.14	1.77	0.32	2.02	114.52	124.88	8.54	47.65
SE	1.46	0.02	0.23	0.04	0.20	15.98	32.37	0.82	7.53	1.85	0.02	0.25	0.03	0.13	11.21	18.27	0.76	6.06
Shika																		
September	18.0	0.30	1.07	0.41	1.50	109.30	345.62	6.46	47.84	13.31	0.11	1.05	0.31	1.14	79.14	535.82	5.60	38.80
November	12.69	0.09	0.35	0.22	2.16	114.94	116.92	5.16	30.06	8.13	0.04	1.55	0.23	1.47	81.30	217.18	2.70	21.34
February	7.81	0.04	0.96	0.27	1.53	100.26	361.26	1.76	45.68	6.00	0.03	0.97	0.27	1.61	93.34	241.72	1.78	68.52
March	4.99	0.04	1.14	0.17	1.09	50.20	134.88	2.24	51.54	4.80	0.03	1.07	0.21	1.26	53.16	174.12	2.44	29.28
April	3.76	0.02	1.27	0.15	0.94	50.12	301.18	2.00	17.52	4.88	0.02	1.51	0.26	1.21	70.48	268.70	2.22	12.34
May	3.38	0.03	0.12	0.12	0.84	92.54	191.60	4.10	22.10	3.81	0.03	0.09	0.16	1.18	70.60	268.70	4.64	16.86
June	13.75	0.18	1.61	0.35	1.47	156.32	273.30	5.98	55.78	13.75	0.18	1.56	0.32	1.17	140.40	269.90	4.44	48.36
July	11.81	0.12	1.60	0.39	1.45	170.70	471.88	6.92	47.88	6.92	0.14	1.63	0.13	1.35	137.78	143.62	6.98	35.40
SE	*1.89*	*0.03*	*0.19*	*0.04*	*0.14*	*15.39*	*42.98*	*0.75*	*5.44*	*1.36*	*5.94*	*1.57*	*0.02*	*0.06*	*11.29*	*14.94*	*0.66*	*6.50*

SE: Standard error

Table 1 presents the effect of seasonal changes on the CP and mineral content of the legumes across three study locations in the SHZ. Generally, the highest CP and mineral contents were recorded in September (wet season), while the period of lowest CP concentration in the legumes occurred between November and May, coinciding with most of the dry season. Crude protein content is less problematic in the wet season, making the forages more available to livestock. However, centro consistently exhibited lower CP levels than Verano stylo during the dry season.

Both legumes showed no appreciable difference in phosphorus (P) content during the dry season, but centro had considerably higher P during the rainy season. Potassium (K) content was relatively high in February at all locations except Shika, while calcium (Ca) levels met animal requirements throughout the period, including both rainy and dry seasons.

Table 2 indicates that CP, P, and copper (Cu) were identified as the most limiting nutrients in the forages, particularly during the dry season, based on recommended critical requirements. Poor forage quality in the SHZ during the dry season, coupled with low dry matter yields, can lead to a feed crisis, causing animals to lose weight, and in extreme cases, die (Mohamed Saleem, 1986; Otchere et al., 1987; Omoregie, 1995;).

The critical dietary P requirement of beef cattle suggested by NRC (1976) is 0.8% in plant herbage. The requirement for lactating cows ranges from 0.18 to 0.29% of the dry ration. However, little (1980) suggested a level of 0.12% as adequate for the growth of cattle. The P requirement of sheep was given as between 0.16 and 0.37% (NRC, 1975). The values obtained in this study can at best meet only the maintenance requirement of the three classes of ruminants. Also, Cu was consistently low and inadequate based on a critical value of 10mg/kg (McDowell et al., 1984). Iron, Mn, and Zn contents in the legumes are not likely to present a problem, based on a critical level of 30mg/kg for ruminants (McDowell, et al., 1984).

CONCLUSION

The study highlights that the levels of crude protein (CP), phosphorus (P), and copper (Cu) in the forages, based on the critical requirements suggested by the National Research Council (NRC) for ruminants, are inadequate, especially during the dry season in the Sub-Humid Zone (SHZ) of Nigeria. These deficiencies indicate potential challenges for livestock growth and production in the region. Given that the critical dietary requirements for CP, P, and Cu are not met during certain periods, particularly in the dry season, the study recommends feed supplementation. Supplementation strategies can include providing additional sources of protein, phosphorus, and copper to the livestock through supplementary feeds or mineral supplements. By addressing these nutritional deficiencies through feed supplementation, there is an expectation of improving animal production and output in the SHZ. This approach becomes crucial during the dry season when forage quality is already poor, and the nutritional needs of livestock may not be adequately met by grazing alone. Finally, this study suggests that feed supplementation is necessary to bridge the nutritional gaps and enhance the overall growth and productivity of livestock in the Sub-Humid Zone, particularly during the challenging dry season. This insight is valuable for developing practical and sustainable strategies to optimize animal nutrition and support the livelihoods of farmers in the region

CONFLICT OF INTERESTS

The authors declare no conflict of interest.

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