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Determination of Maximum Herbaceous Production in Anyigba, a Derived Savanna

[1]Aina, D. O., Okayi, E. And [2]Usman, S. S.
[1,2] *Department of Biological Sciences, Kogi State University, Anyigba.*

Abstract: *In this investigation, an attempt was made to estimate the herbaceous production or the carrying capacity of the derived Savanna vegetation of Anyigba area, Kogi State, Nigeria. Three plots of a hectare each were randomly marked out. Within the 3 plots (burnt, slashed and standing/control), 30 tussocks each were marked out and pegged for weekly observations of new flush or tiller regeneration for a period of six months. By random sampling, monthly fresh weights of herbaceous materials in a 1m^2 quadrat were clipped and weighed with a spring balance in the field and oven dried to obtain the dry weights of the herbaceous materials. There was significant difference in herbaceous production between the plots. There was significant difference in tiller regeneration between the plots. Tiller regeneration was adduced to be responsible for corresponding herbaceous production. The implications of these in a derived savanna were discussed.*
Key words: *Quadrat, herbaceous materials, Derived Savanna, tiller regeneration, herbaceous production.*

I. Introduction

Nigeria has a land mass of 923,768 sq. km with about 80% of it covered with Savanna vegetation (Usman, 2004; Sanford, 1980). This extensive Savanna serves as the food basket of Nigeria upon which the generations to come will depend.

Grass composition decreases Northwards in the Nigerian Savanna. Low production is obtained in the Sudanian zone as a result of excessive grazing (Carr *et al.*, 2005). The climatic factor of moisture regime and possibly temperature, together with heavy livestock grazing during the rainy-season has led to high proportion of annuals and short perennial grasses and low total crop weight. Therefore, climatic, human and soil factors account for the differences in herbaceous productions in Nigerian Savanna (Cook *et al.*, 2005; Abdullahi and Sanusi, 2006; Merbold *et al*., 2008).

Grasses, forbs, shrubs and trees of the Savanna lands are very important to the grazing economy of the country. The Derived Savanna, for example, provides dry season grazing for long distance Fulani cattle. The Savanna lands are particularly still fairly well-stocked and it is there that hopes have been entertained of developing reserves for the rearing of livestock, wildlife and production of crops for food.

In extensively managed Savannas, the productivity of herbaceous plants, notably, the grasses, is of primary importance. The determinants of Savanna ecosystem are modified by man, either directly or indirectly. The determinants may either be primary (such as climate and soil) or secondary (such as fire and the impact of herbivores). The latter are of particular interest since, although they act within the constraints imposed by the primary determinants, they can be controlled or managed. Knowledge of the carrying capacity (herbaceous production) of the Savanna is important for sustainable land use and management. Various authors obtained workable empirical data which serve as guide for management of various Savanna belts (De-Leeuw, 1978; Isichei, 1979; Milligan and Sule, 1980; Usman, 1981; Usman, 1990). Previous studies in Nigeria are in agreement that Fire promotes early flushing of perennial grasses, germination of seeds and increase in herbaceous maximum standing crops (Afolayan, 1980; Fegbenro, 1980; Sanford, 1980; Usman, 1990). Grassland burning on six months basis has been proven to improve fodder for wildlife and livestock (Abdullahi, 2001). Burning of vegetation increases nutrients level which increases herbaceous plant production (Carney *et al*., 2004; Kaye and Hart, 1998). High levels of sodium and high pH are not favourable for the accumulation and mineralization of organic matter (Rengasamy and Olsson, 1991; Naidu and Rangasamy, 1993).

II. Materials And Methods

Study area

Anyigba is located between latitudes 7^{o}301N and longitude 7^{o}101E within the Derived Savanna zone of Nigeria. It has an altitude of 420m above sea level and covers an area of approximately 40 kilometer square. The study was carried out at Iji Phase II area of Anyigba. The site was chosen because of its minimal human impacts and the homogeneous nature of its physiognomy and species composition. The area is characterized by a mean annual rainfall of about 1,000mm. Rainfall begins in April and ends in October. Rainfall has two maxima, July and September. Dry season begins in November and ends in March. Within the dry season, harmattan sets in.

Marking out plots

In the first week of February (2010) when herbaceous materials were dried up, three plots of one hectare each were sampled, following Usman, (1990), marked out, using strides (one stride being an equivalent of one meter). Fire trace was made around each of the plots. Controlled burning was administered in the first plot in March when herbaceous materials were thoroughly dried. The second plot was slashed to the ground level using cutlass and raked out. The third plot remained standing, representing the control plot. These plots were visited on weekly basis and were maintained from March, 2010 till October, 2010 when most herbaceous plants were in their flowering period. In each plot, 30 tussocks of *Andropogon gayanus* were marked out and pegged for weekly observations of new flush or tiller regeneration. The weekly numbers of new tillers were recorded against every pegged tussock in the 3 plots.

Collection of Herbaceous samples

100 slips of paper were made and 50 sampling sites were located using paired numbers. This was done by drawing the first number from the 100 slips to represent the X – co-ordinate and after returning it, drawing the second number to represent the Y-co-ordinate. It is important to return the first slip to give it an opportunity of being picked again (Chapman, 1976). The two co-ordinates were paced and the point of intersection became the centre of the $1m^2$ quadrat. All the above-ground herbaceous materials within the $1m^2$ quadrat were clipped at ground level and weighed on the field using spring balance attached to a tree branch. Sub-samples were also weighed fresh and carried to the laboratory in polythene bags. The sub-samples were air-dried to constant weight and oven-dried to constant weight at 80^oC. The weights of these oven-dried sub-samples were used to estimate the dry weights of the fresh herbaceous materials per m^2 by simple proportion. Using soil auger, soil from 0 – 15cm depth were removed from the 3 plots, air-dried for a week at laboratory temperature of 30^oC and then sieved through a 2mm mesh screen for percentage carbon, percentage organic matter, percentage Nitrogen, available phosphorus and soil pH.

Species Composition

Plants species were identified using the Flora of West Tropical Africa of Hutchinson and Dalziel, (1992). Voucher specimens were of all identified species were prepared and submitted to Kogi State University herbarium. A total of 24 species were recorded (Table 1). Poaceae had the largest number of species followed by Asteraceae and Euphorbiaceae. The commonest species found in the study areas was *Andropogon gayanus* while the rare species was *Tridax procumbens*.

TABLE 1: List of Herbaceous Plants identified in the Study Area

Serial No.	**Botanical Nomenclature**	**Family**
1	*Amaranthus spinosus* Linn	Amarantheceae
2	*Ageratum conyzoides* Linn	Asteraceae
3	*Aspilia africana* (pers.) C.D. Adams	Asteraceae
4	*Bidens pilosa* Linn	Asteraceae
5	*Commelina diffusa* J.K. Morton	Commelinaceae
6	*Commelina erecta* J.K. Morton	Commelineceae
7	*Tridax procumbens* Linn	Compositae
8	*Cnestis ferruginea* DC	Connaraceae
9	*Mariscus alternifolius* Vahl	Cyperaceae
10	*Euphorbia hirta* Linn	Euphorbiaceae
11	*Euphorbia hyssopifolia* Linn	Euphorbiaceae
12	*Phyllantus amarus* Schum & Thonn	Euphorbiaceae
13	*Solesnotemum monostachyus* (P.Beauv) Brig	Lamiaceae

14	*Sida acuta* Burn. F	Malvaceae
15	*Ludwigia decuvens* Walt	Onagraceae
16	*Centrosema pubesens* Benth	Papilionaceae
17	*Andropogon gayanus* Kunth	Poaceae
18	*Andropogon tectorum* Schum & Thonn	Poaceae
19	*Oplimenus barmannii* (Retz) P	Poaceae
20	*Pannicum maximum* Jacq	Poaceae
21	*Pannicum repens* Linn	Poaceae
22	*Pennisetum polystachion* (Linn) Schult	Poaceae
23	*Sporobulus pyramidalis* P. Beauv	Poaceae
24	*Waltheria indica* Linn	Sterculiaceae

III. Results

Herbaceous Production

The total dry weight of herbage production in the burnt plot was 44922.00gm^{-2} and the mean maximum herbaceous production at 0.05 level of significance is 898.44 $\pm$ 51.73gm^{-2}. For slashed plot, the total dry weight was 43217.69gm^{-2} and the mean maximum herbaceous production at 0.05 level of significance is 864.25 $\pm$ 53.88gm^{-2}. While for the control plot, the total dry weight was 29648.43gm^{-2} and the mean maximum herbaceous production, 592.97gm^{-2}. The mean maximum herbaceous standing crop for Anyigba area was 785.25gm^{-2}

TABLE 2: Mean Herbaceous Production for the 3 Plots.

Plots	Mean
Burnt plot	898.44 $\pm$ 51.73gm^{-2}
Slashed plot	864.35 $\pm$ 53.19gm^{-2}
Control plot	592.97 $\pm$ 40.34gm^{-2}

Mean of mean = 785.25gm^{-2}

Fig. 1: Mean Maximum Herbaceous Productions on Plot Basis (with 95% confidence intervals)

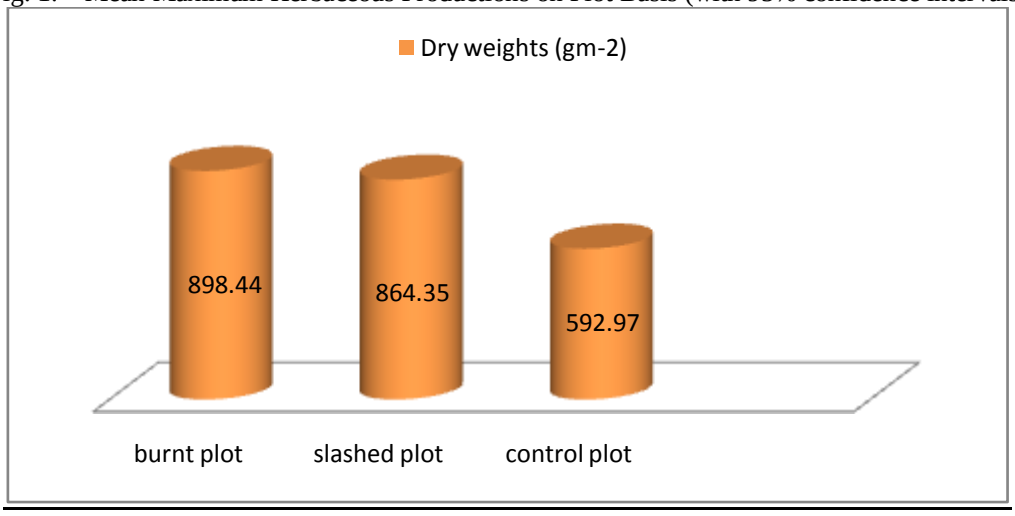

TABLE 3: Comparison of the 3 Plots Using ANOVA

Source of Variation	Degree of Freedom (DF)	Sum of Squares (SS)	Mean Square (MS)	F-calculated
Within Plots	2	661429.31	330714.66	0.0007836
Between Plots	147	-62038146210.0	-422028205.5	
Total	149	-62037484780.0	-421697490.8	

There was significant difference in the herbaceous productions between the plots

IV. Discussion

The maximum herbaceous standing crop obtained at the end of the growing season (October) in the study area was estimated to be 785.25gm^{-2}. This estimate is within the range of 150gm^{-2} - 1800gm^{-2} given by Milligan and Sule, (1980) as the standard range for Nigeria Savannas. This value is an indication of a fertile soil that is continuously covered by herbaceous materials and a potential for livestock production hence the seasonal invasion of these zone by Fulani herdsmen. The Derived Savanna zone of Anyigba area provides much more adequate grazing during the dry season.

This value of 785.25gm-2 differs from that obtained in other Nigerian Savannas in various studies. For example, Usman, (1981) while working in the Northern part of Nigeria (Kainji lake National Park) obtained a range of 115.05 to 468.73gm-2. Estimate ranging from 201gm-2 to 450gm-2 was obtained in North-Eastern Nigeria (De-Leeuw, 1978). A mean of 1092.62gm-2 was obtained from Opi-lake area, Eastern Nigeria (Usman, 1990) while Isichei, (1979) reported 448gm-2 for Olokemeji-Western Nigeria and 331gm-2 for Igbeti, Southern Nigeria. The reasons for these differences in herbaceous productions in the various Nigeria Savannas can be attributed to differences in climate, rainfall, soil and human activities such as burning, livestock-grazing and cultivation. These factors affect both distribution and production of herbaceous materials in an area. Areas that are closer to the coast receive more rainfall than areas far away from the coast (Northern part), this coupled with excessive grazing makes the Northern part of Nigerian Savanna to be dominated by mainly annuals and short perennial grasses with low herbage production. Rainfall in the Derived Savanna area is moderate and stock with tall perennial grasses as livestock grazing is minimal. Herbage production in this area is high compared with the Sudanian part of Nigerian Savanna.

Fire releases minerals in bulk in the form of ash instead of the usual slow process of decay. These ashes from burnt biomass have considerable impact on soil and vegetation. Burning of biomass increases the nutrient content of the burnt plot enriching the soil resulting in rapid growth and the increased herbage of 898.44gm-2 compared to 864.35gm-2 and 592.97gm-2 for the slashed and control plots, respectively (Table 2). The low herbage production in the control plot is as a result of shading effect of the dry shoots on the new ones (tiller) from receiving adequate sunlight and also competition with the new shoots for available water and mineral nutrients. These resulted in stunted growth and decreased herbage production at the end of the growing season. The process of decomposition of organic matter is slow in the slashed plot and is not as effective as when fire is applied.

The estimated maximum herbaceous standing crop of 785.25gm-2 from the present study shows high carrying capacity of the area and a fertile soil that is continuously covered by herbaceous materials. Over-grazing threatens both directly, the supply of animal products and indirectly, food production and thus loss in economic value that could be generated from livestock production. This value will serve as a guide to effective land management and sustainability. Rangeland is envisioned in the future to provide a desirable mixture of economic, ecological and social benefits to current and future generations.

Since previous studies in Nigeria are in agreement that fire promotes early flushing of perennial grasses, germination of seeds and increase in herbaceous maximum standing crops (Afolayan, 1980; Fegbenro, 1980; Sanford, 1980; Usman, 1990), it may be well in order to embark on grassland burning on six months basis as advocated by Abdullahi, (2001) as land management strategy for the sustenance of Nigerian Savanna.

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