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CHANGE IN PERCENTAGE GROUND COVER OF PERENNIAL GRASSES UNDER DIFFERENT BURNING REGIMES*

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Introduction

For a long time fire has been an important factor in the managment of habitats of domestic and wild animals. Many range managers in African savannas use fire successfully to improve the quality and quantity of grass in the habitats (Rains 1963, West 1965, Herlocker 1971). The proportion of the desirable perennial grass species in any habitat affects its ecological stability as well as the animal production in that particular habitat. Therefore, a range manager continues to monitor the conditions and trends of perennial grasses in the habitats in order to determine whether the habitats are downgrading or upgrading. If habitats are downgrading he has to find the reasons for this and take immediate precautions against factors causing habitat degradation in his area.

The percentage of ground covered by perennial grasses and the rate at which they produce new tillers are some of the conditions range managers measure in order to determine the vigor and productivity of perennial grasses in rangelands (Parker 1950, Riney 1963, Egunjobi 1973, Geerling 1973). In the West African savanna zone very little information is available on percentage cover and tillering of the dominant perennial grass species.

This paper presents information on the effects of burning and seasonality on perennial grass species in the Northern Guinean savanna zone of Nigeria. The work was carried out in Kainji Lake National Park in Kwara State of Nigeria. This investigation was carried out in three vegetation types in the Park, namely (a) *Terminalia macroptera* tree savanna, (b) *Isoberlinia tomentosa* woodland, and *Burkea/Detarium* savanna woodland. Adequate description of vegetation, climate and soils of the study area have been given by Afolayan (1975). The annual rainfall in this area ranges from 1000 mm in the eastern part to 1,200 mm in the western part.

Rain falls mainly between May and October, with the highest peak in August and September. The hottest months are March and April just before the early rains start while the coldest months are December and January during the harmattan period.

Methods

Six plots (50 × 20 m each) were sampled in each of the following vegetation types: (a) *Terminalia macroptera* tree savanna (VI); (b) *Isoberlinia tomentosa* woodland (V2); and (c) *Burkea/Detarium* savanna woodland (V3). Six treatments were carried out in each vegetation type as follows: (i) Early burning every year with grazing (T1); (ii) Early burning every year without grazing (T2); (iii) Late burning every year with grazing (T3); (iv) Late burning every year without grazing (T4); (v) Fire excluded with grazing (T5); (vi) Both fire and grazing excluded (T6).

Data on grass species composition and ground cover were collected by using the line-point transect method of Parker (1950).

Ten permanent transects were located in each plot at

* Nomenclature follows Hutchinson & Dalziel 1954–1972. Flora of West Tropical Africa 2nd ed., edited by R.W.J. Keay & F.N. Hepper, Crown Agents, London.

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regular intervals of 5 m. Edge effects were taken care of by leaving 2.5 m wide margins at each edge of the plot. A loop (approximately 19 mm) was dropped at 1 m intervals along each transect on the right hand side of a measuring tape. The tape was aligned with the transect to the bases of the perennial grasses. Whatever the loop touched was recorded. The number of hits on perennial grasses, annual grasses, forbs, litter, woody plant and bare ground were recorded and the percentage of each was calculated. Data collection was repeated in the same way in subsequent years.

In the study area tillers of the dominant perennial grass species were counted monthly in 20 randomly selected quadrats of 1 × 1 m in each of the fire plots.

Results

Tables 1, 2 and 3 present the changes in the perennial grass cover under different burning regimes between October 1973 and October 1975 in the three vegetation types. In the *Terminalia macroptera* tree savanna (Table 1) the plot burnt early and grazed showed a slight increase in percentage bare ground with a slight decrease in percentage bare ground with a slight decrease in percentage litter during the period between October 1973 and October 1975. The percentages of perennial grass basal cover and perennial grass canopy cover were also slightly reduced during the same period, while the percentages of annual grass, forbs and woody plant increased. The plot burnt

Table 1. Changes in ground cover and life form of herbs in *Terminalia macroptera* fire plots

Treatment	Bare ground		% litter		% pgc* basal		% pgc* canopy		% annual + gc		% forbs		% woody plant	
	Oct. 73	Oct. 75	Oct. 73	Oct. 75	Oct. 73	Oct. 75	Oct. 73	Oct. 75	Oct. 73	Oct. 75	Oct. 73	Oct. 75	Oct. 73	Oct. 75
T1	7.77 ±1.04	8.47 ±1.60	5.18 ±0.80	4.48 ±0.50	29.57 ±4.35	27.34 ±3.78	41.00 ±5.14	39.87 ±4.89	1.45 ±0.20	3.68 ±0.46	12.95 ±2.01	13.10 ±1.56	2.08 ±2.07	3.06 ±0.32
T2	3.94 ±0.67	3.57 ±0.58	6.90 ±1.36	7.27 ±1.28	31.77 ±3.47	32.50 ±3.28	50.00 ±5.67	52.73 ±4.58	0.49 ±0.07	0.32 ±0.04	6.90 ±1.03	3.44 ±0.43	0.00	0.17 ±0.03
T3	7.29 ±1.02	6.40 ±1.10	9.90 ±1.78	5.82 ±1.36	29.00 ±4.36	35.16 ±4.78	36.10 ±5.06	44.80 ±5.68	0.00	0.00	17.71 ±2.04	7.82 ±1.78	0.00	0.00
T4	9.45 ±1.65	7.28 ±1.03	5.47 ±1.01	3.56 ±0.62	28.32 ±4.37	32.66 ±3.89	40.30 ±4.56	49.41 ±6.76	0.00	0.00	14.43 ±2.03	5.32 ±1.10	1.99 ±0.21	1.77 ±0.28
T5	12.87 ±2.47	11.37 ±2.04	9.90 ±1.97	15.92 ±2.88	32.16 ±4.67	24.50 ±3.68	41.11 ±5.68	37.74 ±4.89	0.00	0.00	3.96 ±0.57	10.42 ±1.98	0.00	0.00
T6	5.45 ±1.00	7.65 ±1.02	9.90 ±1.76	16.85 ±2.16	30.78 ±5.67	26.20 ±3.45	41.00 ±5.97	31.48 ±4.66	0.00	0.00	12.38 ±2.32	16.52 ±2.47	0.5 ±0.06	1.30 ±0.21

*pgc = Perennial grass cover +gc = grass cover
Confidence limits were calculated at 95% probability level (P = 0.5)

Table 2. Changes in ground cover and floristic composition of herbs in *Isoberlinia* Woodland fire plots

Treatments	Bare ground		% Litter		% Pg* Basal cover		% Pg Canopy cover		% Annual grass cover		% Forbs		% Woody plant	
	Oct. 73	Oct. 75	Oct. 73	Oct. 75	Oct. 73	Oct. 75	Oct. 73	Oct. 75	Oct. 73	Oct. 75	Oct. 73	Oct. 75	Oct. 73	Oct. 75
T1	10.61 ±1.81	11.11 ±1.06	28.28 ±3.67	27.88 ±4.52	18.54 ±2.66	15.32 ±2.08	33.99 ±4.31	27.00 ±2.56	7.05 ±0.80	16.16 ±2.26	1.03 ±0.12	2.02 ±0.23	0.51 ±0.06	0.51 ±0.05
T2	13.00 ±1.98	17.60 ±2.03	24.50 ±3.65	23.39 ±3.89	23.00 ±2.45	20.00 ±2.89	30.00 ±4.63	29.56 ±3.99	0.00	0.00	0.00	0.00	9.50 ±1.04	9.45 ±0.98
T3	8.33 ±1.46	4.70 ±0.98	23.96 ±3.46	15.17 ±2.43	19.56 ±2.04	28.50 ±3.67	39.76 ±4.89	44.76 ±5.06	4.90 ±0.50	3.64 ±0.20	0.49 ±0.07	0.30 ±0.02	3.00 ±0.45	3.00 ±0.37
T4	18.60 ±2.04	16.47 ±2.66	22.39 ±3.01	14.80 ±2.58	18.06 ±3.08	24.90 ±2.97	40.50 ±4.76	43.37 ±5.66	0.00	0.00	0.00	0.00	0.45 ±0.04	0.45 ±0.07
T5	9.12 ±0.70	8.25 ±0.96	9.90 ±1.04	19.42 ±2.89	20.83 ±3.03	10.00 ±1.62	42.00 ±5.15	24.95 ±3.06	8.20 ±1.14	16.02 ±2.10	1.21 ±0.19	12.45 ±1.46	8.74 ±0.98	8.91 ±0.83
T6	16.03 ±2.45	13.27 ±1.39	16.53 ±2.08	23.80 ±3.67	20.00 ±3.86	15.41 ±2.45	34.27 ±4.62	30.00 ±4.03	11.16 ±1.01	13.27 ±1.89	0.00	2.04 ±0.20	2.01 ±0.31	2.22 ±0.46

Confidence limits were calculated at 95% probability level (P = 0.05)
*Pg = Perennial grass

early without grazing showed a slight decrease in the percentage bare ground with a corresponding increase in percentage litter. Both percentage perennial grass canopy cover showed a slight increase during the period of study. Percentage annual grass cover and percentage forbs decreased slightly, while the percentage woody cover increased.

In the late burnt plots the percentages of bare ground and litter decreased during the period while the percentage perennial grass cover increased remarkably. No annual grasses were recorded; the percentages of forbs decreased considerably and the percentage of woody plant decreased slightly.

The unburnt plots accumulated a higher proportion of litter with a corresponding decrease in the amount of bare ground. The percentages of the perennial grass cover decreased considerably with a corresponding notable increase in proportions of forbs. No annual grasses were recorded in the unburnt plots. An increase from 0.5 to 1.30 was noticed in the percentage woody plant in the unburnt plot without grazing (T6) where woody plants occurred.

The result of the *Isoberlinia* woodland fire plots (Table 2) are very similar to those obtained in the *Terminalia macroptera* fire plots. In this vegetation type the two early burnt plots percentage bare ground increased while the proportions of litter slighly decreased and the percentages of perennial grass cover decreased while those of annual grass cover and forbs increased remarkably. Very little changes took place in the percentages of woody plants in the two plots. The two late burnt plots showed remarkable decreases in the proportions of bare ground and litter while the percentages of the permienial grasses increased considerably. The percentages of the annual grass cover and forbs decreased and the percentages of the woody plants remained unchanged.

The proportions of litter and of the annual grasses and forbs increased in the unburnt plots while there was a decrease in the proportion of bare ground and of the perennial grass cover. Very little changes were noticed in the percentages of the woody plants.

The results obtained in the *Burkea/Detarium* fire plots (Table 3) more or less followed the same pattern as the ones described previously for the *Terminalia macroptera* savanna and the *Isoberlinia* woodland. In the plot burnt early with grazing the percentages of litter and bare ground as well as that of annual grasses, forbs and woody plants increased, whereas the proportions of perennial grass cover decreased.

The plot burnt early without grazing showed an increase in the proportion of bare ground exposed with a corresponding decrease in the proportion of litter accumulation. The perennial grass cover percentage decreased, while those of annual grasses, forbs and woody plants increased. The percentages of bare ground decreased in the late burnt plots with notable increase in the percentages of perennial grass cover. The percentages of annual grasses, and forbs decreased considerably. Slight decrease was also noticed in the percentage woody plant in each of the late burnt plots. The unburnt plots, as usual, showed a remarkable increase in the percentages of litter accumulated during the period with a corresponding decrease in the proportions of bare ground. The percentages of the perennial grass cover decreased remarkably while those of annual grasses, forbs and woody plants increased.

Table 3. Changes in ground cover and floristic composition of herbs in *Burkea/Detarium* fire plots

Treatments	% Bare ground		% Litter		% Pg basal cover		% Pg Canopy cover		% Annual grass cover		% Forbs		% Woody plants	
	Oct. 73	Oct. 75	Oct. 73	Oct. 75	Oct. 73	Oct. 75	Oct. 73	Oct. 75	Oct. 73	Oct. 75	Oct. 73	Oct. 75	Oct. 73	Oct. 75
T1	24.30 ±2.46	29.40 ±3.04	5.34 ±0.60	7.40 ±0.98	18.13 ±2.41	16.00 ±1.56	42.52 ±4.78	34.04 ±3.59	0.00	0.49 ±0.06	5.83 ±0.53	6.90 ±0.85	3.88 ±0.67	5.77 ±0.74
T2	23.30 ±3.46	25.00 ±4.78	8.87 ±1.27	5.47 ±0.98	16.14 ±2.68	13.89 ±2.06	39.00 ±4.10	33.77 ±4.09	2.35 ±0.36	3.45 ±0.57	7.88 ±1.14	14.43 ±2.03	2.46 ±0.37	3.99 ±0.89
T3	17.62 ±2.33	15.45 ±2.78	8.97 ±1.54	4.90 ±0.67	19.51 ±3.54	23.36 ±4.03	35.00 ±4.80	43.42 ±5.73	5.00 ±0.62	3.00 ±0.49	8.52 ±0.72	5.38 ±0.69	5.38 ±0.86	4.50 ±0.76
T4	21.40 ±3.52	17.87 ±2.67	8.81 ±1.40	7.90 ±1.23	18.90 ±2.70	25.27 ±3.09	40.00 ±4.86	43.00 ±4.59	1.57 ±0.29	0.00	7.25 ±1.01	3.96 ±0.61	2.07 ±0.39	2.00 ±0.32
T5	20.95 ±2.61	17.29 ±3.01	10.95 ±1.70	19.90 ±2.91	21.47 ±3.56	17.54 ±2.43	32.21 ±4.49	22.46 ±2.32	4.53 ±0.60	8.44 ±1.03	8.90 ±1.12	13.01 ±1.67	1.00 ±0.14	1.36 ±0.21
T6	23.77 ±2.39	17.85 ±2.67	5.18 ±0.79	19.42 ±2.05	18.47 ±2.31	12.45 ±1.89	42.10 ±5.69	27.55 ±3.46	1.45 ±0.39	6.63 ±0.71	6.95 ±0.98	13.09 ±1.63	2.07 ±0.35	3.00 ±0.48

Confidence limits were calculated at 95% probabilitylevel (P = 0.05)

Table 4. Effects of treatments and seasonal variations on tillering in two grass species in *Terminalia macroptera* fire plots

Treatments	July 1974	August 1974	Sept. 1974	July 1975	Aug. 1975	Sept. 1975	Species
T1	4.56 ± 0.81	5.30 ± 0.79	5.39 ± 0.64	3.89 ± 0.51	5.20 ± 0.47	5.12 ± 0.68	Bj
	6.04 ± 0.64	7.51 ± 0.93	8.60 ± 1.39	5.62 ± 0.71	6.98 ± 0.80	7.84 ± 0.93	Ss
T2	3.14 ± 0.43	4.91 ± 0.61	5.02 ± 0.73	4.65 ± 0.62	5.11 ± 0.75	6.14 ± 0.66	Bj
	7.48 ± 0.83	7.05 ± 0.96	8.98 ± 1.25	6.72 ± 0.98	7.58 ± 1.09	8.17 ± 0.92	Ss
T3	7.19 ± 0.91	7.88 ± 0.80	7.00 ± 0.99	6.63 ± 0.79	7.44 ± 0.65	8.10 ± 1.21	Bj
	8.33 ± 1.04	9.45 ± 0.87	10.06 ± 1.93	9.03 ± 1.73	10.15 ± 2.12	9.87 ± 1.68	Ss
T4	8.10 ± 1.36	7.59 ± 0.90	8.34 ± 1.42	5.12 ± 0.72	6.78 ± 0.83	9.14 ± 1.74	Bj
	9.45 ± 1.47	10.01 ± 1.67	11.32 ± 2.09	8.81 ± 1.68	9.61 ± 1.34	10.32 ± 2.86	Ss
T5	2.46 ± 0.40	3.04 ± 0.43	4.19 ± 0.53	3.21 ± 0.48	4.03 ± 0.36	4.52 ± 0.64	Bj
	4.27 ± 0.56	5.71 ± 0.74	6.09 ± 0.89	5.14 ± 0.60	5.20 ± 0.59	6.01 ± 0.91	Ss
T6	1.37 ± 0.23	2.56 ± 0.41	3.89 ± 0.65	2.21 ± 0.21	3.37 ± 0.57	3.96 ± 0.42	Bj
	5.35 ± 0.56	6.31 ± 0.76	5.07 ± 0.69	3.54 ± 0.41	4.67 ± 0.53	5.65 ± 0.61	Ss

Bj = *Brachiaria jubata* Ss = *Setaria sphacelata* (N.B. These two grass species were found only during the early part of the rainy season).
Confidence limits were calculated at 95% probability level on the mean number of tillers per quadrat.

Table 5. Effects of treatments and seasonal variations on tillering in three grass species in *Terminalia macroptera* fire plots.

Treatments	Oct. 1974	Nov. 1974	Jan. 1975	Oct. 1975	Nov. 1975	Jan. 1976	Species
	16.50 ± 2.03	17.85 ± 2.47	17.03 ± 2.60	18.63 ± 3.99	18.06 ± 3.02	17.89 ± 1.89	Hr
T1	30.44 ± 4.67	36.81 ± 4.66	31.29 ± 4.93	32.93 ± 5.62	41.62 ± 6.14	29.90 ± 3.44	Hc
	12.36 ± 1.89	19.06 ± 2.09	18.70 ± 2.34	14.31 ± 1.80	17.89 ± 2.80	16.97 ± 1.46	Ap
	15.69 ± 1.23	16.56 ± 2.32	15.85 ± 1.67	14.95 ± 1.26	15.61 ± 2.40	16.53 ± 2.56	Hr
T2	25.62 ± 2.62	34.67 ± 4.60	30.21 ± 4.32	29.56 ± 3.12	32.67 ± 3.39	30.11 ± 4.08	Hc
	13.88 ± 2.01	21.69 ± 3.56	17.83 ± 2.41	15.30 ± 1.88	23.99 ± 2.80	22.46 ± 3.10	Ap
	22.46 ± 2.09	28.73 ± 4.22	26.04 ± 3.52	20.61 ± 2.12	26.29 ± 3.08	25.60 ± 3.29	Hr
T3	49.51 ± 1.43	56.22 ± 5.98	43.19 ± 6.32	36.40 ± 3.49	44.91 ± 6.59	38.62 ± 2.06	Hc
	21.44 ± 3.56	24.80 ± 3.51	23.69 ± 3.21	19.64 ± 2.18	22.30 ± 2.56	20.98 ± 2.17	Ap
	21.41 ± 2.67	26.50 ± 4.21	26.10 ± 3.35	23.63 ± 2.23	27.91 ± 4.81	26.93 ± 3.42	Hr
T4	37.90 ± 3.56	40.99 ± 5.63	31.56 ± 3.09	36.96 ± 4.98	43.54 ± 4.63	40.73 ± 4.91	Hc
	18.46 ± 2.58	23.29 ± 2.12	19.15 ± 1.27	17.73 ± 1.85	26.41 ± 3.03	25.82 ± 3.06	Ap
	15.73 ± 1.88	19.59 ± 1.69	14.64 ± 1.99	13.56 ± 2.69	17.42 ± 2.08	16.26 ± 2.61	Hr
T5	23.46 ± 2.42	29.40 ± 3.42	26.03 ± 2.47	20.26 ± 3.41	31.60 ± 4.60	27.49 ± 3.58	Hc
	9.07 ± 1.03	16.33 ± 2.13	11.09 ± 1.91	10.6 ± 1.63	17.81 ± 2.32	14.76 ± 1.14	Ap
	13.67 ± 1.62	14.22 ± 2.46	13.89 ± 1.89	12.98 ± 1.89	13.01 ± 0.98	11.55 ± 1.11	Hr
T6	19.88 ± 1.49	27.41 ± 3.94	21.86 ± 2.36	22.24 ± 2.20	29.66 ± 4.62	27.27 ± 2.37	Hc
	10.49 ± 0.98	15.55 ± 1.87	12.06 ± 1.98	11.08 ± 1.06	16.40 ± 2.86	15.25 ± 1.27	Ap

Hr = *Hyparrhenia rufa;* Hc = *Hyparrhenia cyanescens;* Ap = *Andropogon perligulatus* (N.B. These three grass species became visible only during the later part of the rainy season)
Confidence limits were calculated at 95% probability level on the mean number of tillers per quadrat.

Table 6. Effects of treatments and seasonal variations on tillering in two grass species in *Isoberlinia* Woodland fire plots, September 1975 to December 1975.

Treatments	Sept. 1975	Oct. 1975	Nov. 1975	Dec. 1975	Species
T1	2.70 ± 0.39	3.17 ± 0.48	4.40 ± 0.53	3.95 ± 0.52	Bu
	4.68 ± 0.82	6.95 ± 0.79	8.47 ± 0.96	8.96 ± 1.13	Hs
T2	3.69 ± 0.40	4.90 ± 0.76	7.85 ± 0.99	6.53 ± 0.94	Bu
	6.04 ± 0.53	8.63 ± 1.14	8.71 ± 1.63	7.56 ± 1.03	Hs
T3	6.91 ± 0.73	7.34 ± 0.85	9.12 ± 1.72	8.41 ± 0.84	Bu
	8.42 ± 1.25	9.16 ± 1.62	9.87 ± 1.32	8.62 ± 1.01	Hs
T4	5.88 ± 0.66	6.97 ± 0.89	10.24 ± 1.04	9.09 ± 1.26	Bu
	8.60 ± 1.10	9.52 ± 1.19	9.64 ± 1.67	12.83 ± 2.59	Hs
T5	4.67 ± 0.65	4.91 ± 0.51	5.95 ± 0.62	3.21 ± 0.48	Bu
	5.08 ± 0.79	6.77 ± 0.70	7.24 ± 0.75	5.36 ± 0.60	Hs
T6	2.78 ± 0.41	4.93 ± 0.44	4.61 ± 0.58	3.29 ± 0.57	Bu
	3.37 ± 0.46	4.66 ± 0.83	6.70 ± 0.71	4.69 ± 0.86	Hs

Bu = *Beckeropsis uniseta;* Hs = *Hyparrhenia smithiana.* Confidence limits were calculated at 95% probability level on the mean number of tillers per quadrat.

Effects of treatments and season on tillering in grass species are shown in Tables 4–7. Table 4 presents the changes in the number of tillers produced by the two early growing grass species in *Terminalia macroptera* vegetation. These two grass species produced more tillers under late burning than in early burnt and unburnt plots. Under all the treatments *Setaria sphacelata* produced more tillers than *Brachiaria jubata.* Number of tillers increased gradually from July to September; from then onwards these two species started to disappear and became superseded by the *Hyparrhenia* and *Andropogon* species shown in Table 5. These tall grass species also produced more tillers under late burning than in the early burnt and unburnt plots. The unburnt plots produced the lowest number of grass tillers. The highest number of tillers were produced in November after which the numbers declined. *Hyparrhenia cyanescens* produced the highest number of tillers in each treatment while *Andropogon perligulatus* had the lowest number. *Hyparrhenia rufa* showed intermediate results in almost all cases.

In table 6, the development of tillers in two grass species in the *Isoberlinia* woodland vegetation is presented. *Beckeropsis uniseta* had a lower number of tillers than *Hyparrhenia smithiana* under all the treatments. The number of tillers increased gradually during the year till November after which it declined. The late burnt plots had the highest number of tillers in all seasons while the unburnt plots had the lowest number. Table 7 present the

Table 7. Effects of treatments and seasonal variations on tillering in *Loudetia flavida* in *Burkea/Detarium* fire plots, August 1975 to November 1975.

Treatments	Aug. 1975	Sept. 1975	Oct. 1975	Nov. 1975
T1	15.93 ± 2.07	19.88 ± 3.13	23.60 ± 2.94	17.26 ± 2.83
T2	14.59 ± 2.05	21.63 ± 2.61	25.94 ± 3.37	24.03 ± 4.80
T3	31.33 ± 4.53	37.85 ± 4.06	47.93 ± 5.36	40.39 ± 5.87
T4	28.57 ± 2.91	35.36 ± 4.58	42.08 ± 6.21	37.77 ± 4.32
T5	12.46 ± 1.05	18.98 ± 3.66	20.42 ± 3.47	20.10 ± 2.19
T6	13.04 ± 2.22	14.69 ± 1.86	19.08 ± 3.40	17.13 ± 2.72

Confidence limits were calculated at 95% probability level on the mean number of tillers per quadrat.

development in *Loudetia flavida*, a perennial grass in the *Burkea/Detarium* vegetation. The results are quite similar to those obtained in the 6ther two vegetation types. The grass produced the highest number of tillers under late burning while it produced the lowest in the absence of burning. Tillers increased in number from August to October after which they declined.

Discussion

The quality and quantity of herbage available in various habitats are very important to the managemant of wildlife populations (de Vos 1969). In Tables 1, 2 and 3 the changes in the perennial grass cover under different burning and grazing regimes are presented.

In all three vegetation types perennial grasses established higher basal cover under late burning treatments than under early burning and no burning treatments. In contrast to this, the annual grasses, forbs and woody elements showed better development under early burning and no burning treatments than under late burning. The results showed that late fires destroyed litter which otherwise would have hindered the growth of grasses, while no burning treatment caused accumulation of litter especially at the beginning of the growing season. Hopkins (1965, 1966) also observed that burning destroyed litter quicker than the normal process of decay. West (1965) had observed that destruction of litter by burning stimulates the growth of a new herbage flush which is important for grazing animals. With burning fire hazard of accumulated old grass is removed and the unpalatable growth left over from previous seasons is destroyed and replaced by young grass flush which is more nutritious and palatable for grazing animals. The results so far obtained show that late burning could be used effectively in the study area to enhance the establishment of perennial grasses at the expence of the annual grasses. Similar observations have been made by Rains (1963) at Shika near Zaria in the Northern Guinean Savanna vegetation. Early burning and no burning treatments seem to have encouraged annual grasses at the expense of perennial grass species. Since the ultimate aim of a range manager is to encourage perennial grass species he needs to use late burning at prescribed intervals in order to achieve his objectives. In addition to providing adequate quantity and quality of forage needed perennial grasses play an essential role in stabalizing the soil, especially in the savanna.

The effects of the treatments on tillering in grass species were very similar for all three vegetation types (Tables 4 to 7). The highest numbers of tillers were produced under late burning treatments while the lowest numbers occurred under no burning treatments. The early burning plots show intermediate results.

This study demonstrated that late burning is an effective tool in encouraging the development of perennial grasses in rangelands but it should be noted that late burning should not be used too frequently in the habitat as it will result into a great loss of organic matter on the top soil. (Nye & Greenland 1960, Moore 1960). It is thus necessary to use late burning only occasionally in the habitats and the most suitable interval at which such burning should be carried out must be determined from a long-term experimental study.

Summary

Differences in the ground and perennial grass covers under different burning and grazing regimes are presented for three vegetation types in Kainji Lake National Park.
It is shown from the results that perennial grasses established higher basal cover under late burning treatments than under early burning and no burning treatments. Late fires destroy litter which hinders grass growth while no burning treatments cause accumulation of litter. The highest number of grass tillers are produced under late burning treatments, while the lowest occurred under no burning treatments. The early burning plots have intermediate results. Occasional late burning in controlled small blocks of land is recommended for optimum grass production in the study area.

References

Afolayan, T.A. 1975. Methods of assessing the effects of burning and grazing on different vegetation communities in savanna woodland. Proc. Ibadan/Garoua International Wildl. Symp. Sept. 1975, at University of Ibadan, Nigeria. In press.

Egunjobi, J.K. 1973. Dry matter, nitrogen and mineral element distribution in an unburnt savanna during the year. Oecol. Plant. 8: 353–362.

Geerling, C. 1973. Vegetation map of Borgu Game Reserve. Unpublished manuscript, Department of Forest Resources Management, University of Ibadan, Nigeria.

Herlocker, D. 1971. Fire management plans, Seronera Valley, Serengeti National Park, Tanzania. Annual publication of Serengeti Research Institute 1971.

Hopkins, B. 1965. Observations on savanna burning in the Olokemeji Forest Reserve, Nigeria. J. Appl. Ecol. 2: 367–381.

Hopkins, B. 1966. Vegetation of the Olokemeji Forest Reserve, Nigeria IV. The litter and soil with special reference to their seasonal changes. J. Ecol. 54: 687–703.

Moore, A. W. 1960. The influence of annual burning on a soil in the derived savanna zones of Nigeria. 7th Trans. Int. Congr. Soil Sc. 4: 257–264.

Nye, P.H. & Greenland, D.J. 1960. The soil under shifting cultivation. Tech. Comm. 51, Commonwealth Bur. Soils, 156 pp.

Parker, K.W. 1950. Report on the three step method for measuring condition and trend of forest ranges. U.S.D.A. For. Ser., Washington, 68 pp.

Rains, A.B. 1963. Grassland research in northern Nigeria 1952–1962. Samaru Misc. paper no. 1, Inst. for Agric. Res., Ahmadu Bello University, Nigeria.

Riney, T. 1963. A rapid field technique and its application in describing conservation status and trends in semi-arid pastoral areas. African Soils 8: 159–258.

de Vos, A. 1969. Ecological conditions affecting the productions of wild herbivorous mammals on grassland. Adv. Ecol. Res. 6: 137–183.

West, O. 1965. Fire in vegetation and its use in pasture management with special reference to tropical and subtropical Africa. Comm. Bur. Past. & Fld. Crops (mimeo) no. 1/1965.

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