Dung Deposition, Breakdown and Grazing Behavior of Beef Cattle at Two Seasons in a Tropical Grassland Ecosystem

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Abstract

The effects of seasons on size, number and area of the dung deposited on a grazed paddock were examined. Rate of dung breakdown, herbage fouling, and rejection were also investigated. Significant seasonal differences were found in number, size, area of dung and in proportion of paddock fouled per grazing such that these values were higher in wet than in dry season. A higher breakdown rate was obtained in the dry season when the termites were the main degradation agents than in the wet season when the dung was degraded mainly by the copriphilous fungi. The herd rejected the fouled herbage for a longer period during wet season than during the dry season. Two breakdown patterns for the dry season (depending on the presence of termites in the ecosystem) were suggested. Herbage rejection was discussed in relation to animal production and range improvement.

In the tropics, use of synthetic fertilizer for herbage production is an infrequent practice. The pasture, for its nutrient supplies, has to depend on both the crop's inherent ability to fix nitrogen and on nutrient recycling. Where the pasture is grazed, the latter process then includes dung voiding and breakdown. However, in many parts of the tropics, including the derived savannah zone of Nigeria, few studies have been conducted to assess the role of the dung in maintaining the ecosystem's nutrient cycle. In the temperature latitudes, the dung has been shown to be affected by both climatic and biotic factors. Dung voided in summer disappeared more slowly than that voided in winter (MacDiarmid and Watkin 1972). Arthropods, fungi, and bacteria have all been implicated in dung breakdown. Castle and MacDaid (1972) reported rejection of the herbage around the pats up to one year after they were voided.

In the present experiments, the influence of the seasons on size, number, and rate of breakdown of the dung voided was examined. Also, the organisms involved in the breakdown and the behaviour of the grazing animals to the dung in the paddock were investigated.

Materials and Methods

The investigations were during the two main climatic seasons—wet and dry seasons. The experimental site was the University of Nigeria Farm, Nsukka, in the derived savanna belt of Nigeria. The derived savanna is the intermediate zone between the rain-forest and the savanna zones and is open park land derived from the forest and maintained by the regular use of fire (Hopkins 1965, McIlory 1972). The droppings were collected from Ndama beef cattle grazing on *Cynodon nlemfnensis/Stylosanthes guenensis-/Pureraria phaseoloides* mixture. The herd's age range was 2–3 years. The dry season study period was from February 19 to April 6 and the wet season July 12 to September 13 (Fig. 1).

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The cattle remained in a paddock in the daytime and were kept in stall at night. Therefore, estimates are only of the periods they were on the pasture. At each study period, the number of pats desposited in the paddock were counted. Thirty samples were removed and weighed fresh before subsampling for dry matter determination. Most samples were nearly circular in shape and therefore the dung's radius was determined in situ. Where the shape was different, appropriate measurements for dung area determination were also taken. Dung consistency was rated on a 1–5 scale (1 = watery; 5 = very hard).

Rate of breakdown was determined by weighing 300 fresh sample into a 25 × 25 cm nylon mesh bag having 1 × 1 mm pores. The samples were deposited in the paddocks in which the aftermath would not be grazed. Dung life has been shown to be unaffected by whether the paddock was grazed and ungrazed (Bastiman & ver Dijk 1975). At weekly intervals duplicate samples were picked up for air drying to constant weight at room temperature (28° C). The paddocks used were cut during the subsequent aftermath grazings. The dry season breakdown rate was not determined beyond 6 weeks as termite casts had covered the samples.

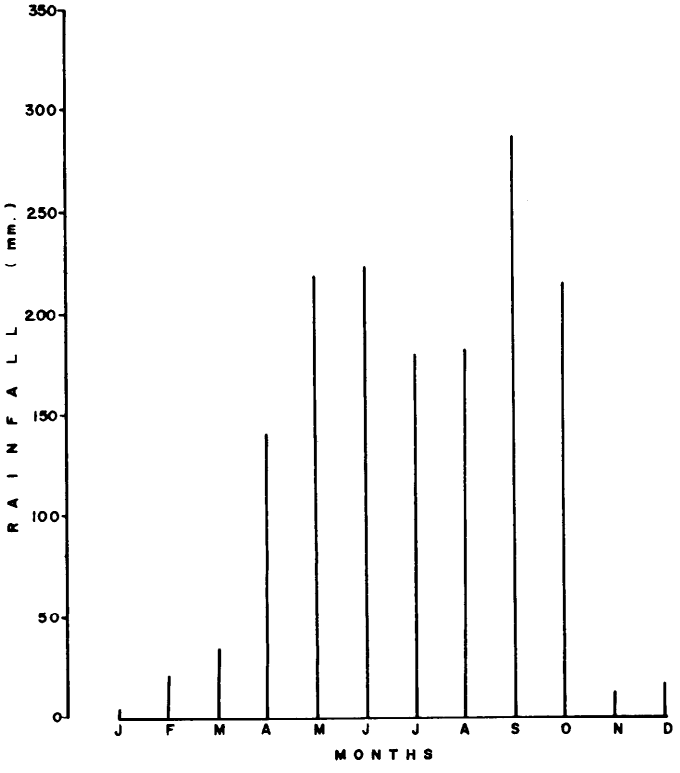

Fig. 1. *Mean monthly rainfall distribution in Nsukka based on 10 years average.*

Some dungs were marked in the paddocks to be regrazed after 4 weeks or 6 weeks interval for wet and dry seasons, respectively. These dungs were used for studying the animal behaviour towards the dung pats in the paddock. At subsequent grazings, the distance the animals grazed away from the dung gave an estimate of the degree of rejection, by the cattle, of the herbage contaminated with the dung. Grazing the aftermath on the dung spot indicated end of the rejection. Effect of grazing pressure on the rejection was also observed. Two sets of animals were used. The first set was allowed to graze the same paddock size at the two seasons, which gave differing pressures. The second set had the number altered so that the same quantity of herbage was available to each animal at the two seasons.

Most probable number (MPN) estimates of the fungal populations were made using a 10^{-4} dilution for the dung samples and a 10^{-3} dilution for the soil sample. Rose-bengal streptomycin agar (Martin 1950) was used and the plates incubated for 4 days at 27° C. Counts of micro and macro-arthropods associated with the dung breakdown were not made.

Results

The total rainfall for the dry and wet seasons was 83.0 and 691.0 mm, respectively. The weekly distributions are shown in Figure 2. Soil temperature at 10-cm depth averaged 31.3 and 37.5° C for the wet and dry seasons, respectively. These values are considered typical for this region as shown in Figure 1.

Attributes of the dung are shown in Table 1. Nearly double the number of voidings were made in the wet season, than in the dry though there were no significant changes in their dry-weights. The mean area per dung voided during the dry season was only half that voided during the wet season. The wet season's dung was less consistent than dry-season's due to increased % moisture, which then probably accounts for the increased area of the wet season's dung. After each grazing during the dry season, approximately 0.02% of the paddock was covered by the dung pats. During the wet season, this increased to about 0.05% of the paddock area. Assuming four grazings at six weekly intervals during the dry season and six grazings at four weekly intervals during the rains, about 0.38% of the paddock will be covered annually by fresh dung.

The herbage around the dung was rejected by the animals. Where the grazing pressure was kept the same for both seasons, there were no marked seasonal differences in herbage rejection. However, in this ecological zone, during the wet season there is more herbage on offer to the livestock. Under this situation seasonal effects on rejection became obvious. During the dry season the herbage around and above the dung was grazed to about 15 cm, 6 weeks later. In the second aftermath grazing, that is 12 weeks after voiding, the entire dung pat area was grazed over. The situation was different during the wet season. Rejection continued beyond 12 weeks, though, in each subsequent grazing, the amount of herbage rejected continued to decrease.

The breakdown rates are shown in Figure 2. At any dung age, more dry matter was lost during the dry season than during the wet season. In the first 4 weeks from voiding, the dry season rate was, at least, double that of the wet season. By 6 weeks, less than 20% of the dry season dung vs. nearly 50% of the wet season dung remained. The most rapid rate was recorded within the first 2

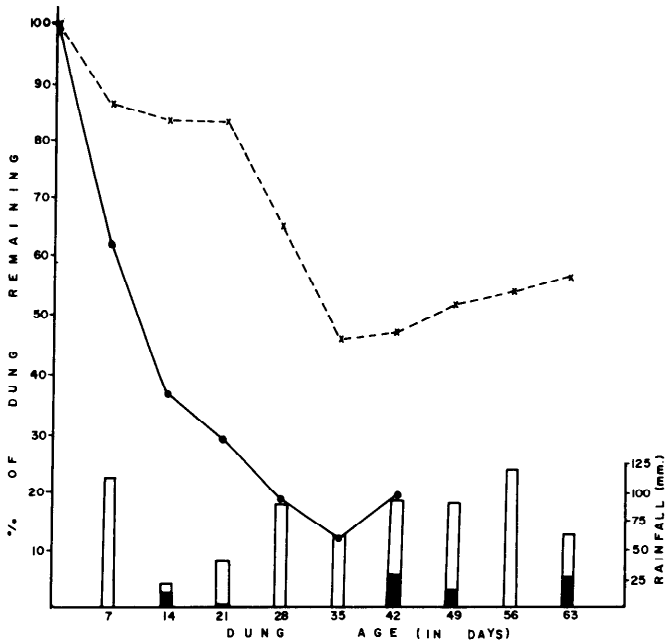

Fig. 2. *Dung breakdown in dry (_____) and wet (- - - -) seasons and weekly rainfall total for dry (■) and wet (□) seasons.*

weeks and the third to fifth weeks for dry and wet seasons, respectively. Dung disappearance stated about 2–3 hours after voiding with the dung beetles carting away some of the dung into their burrows. More was removed from the moist dung than from the firm droppings. Mites and insects were also involved in the dung breakdown. The apparent decrease in rate of breakdown after 6 weeks in wet season is due to soil contamination of the dung. The dry season breakdown in this ecosystem was predominantly by termites, which were nearly absent during the wet season. The wet season breakdown would, therefore, appear to be due mainly to the activities of the coprophilous fungi. The number and types of these fungi associated with the wet season dung breakdown are shown in Table 2. The main groups are the *Aspergillus* and *Penicillium* species. *Rhizopus* species were not isolated from the dung within this period. *Aspergillus* spp were the most numerous types and were found on the dung at voiding.

Discussion

The mean pat size was low compared with values obtained by other workers in temperate region (MacDiarmid and Watkin 1972, Bastiman and ver Dijk 1975). The season affected the dung size and number in that more dung was voided during the wet season than during the dry season. This is similar in trend but not in magnitude to results of MacDairmid and Watkin (1972) with dairy cows in which 13.4, 11.4, and 16.8 voidings/cow/day were recorded for winter, spring, and summer periods, respectively. In the derived savanna ecosystem, feed shortages during the dry season are severe and may account for the wider differences in the number of voidings between the two seasons.

Table 1: Mean dry wt, number/grazing day, area/patch, consistency of dung, and proportion of paddock fouled at each grazing during 2 seasons.

Season	Mean dung dry wt. (g/dung)	Mean voidings per cow/ grazing day	Mean area/patch (cm^2)	% of paddock fouled/grazing	Dung consistency
Dry	160.3	6.8	112.98	0.02	4-5
Wet	189.5	11.4	235.22	0.05	3
Level of significance	NS[1]	*2	***	**	NS

1. NS = non significant
2. *, **, *** = significant differences at 5, 1, 0.1% probabilities respectively.

Table 2. Types and numbers (MPN/g dry soil) of coprophilous fungal groups involved in early stages of dung breakdown.

Type	Substrate	Period at voiding	7 days after voiding	14 days after voiding
Rhizopus spp	Dung	0	0	0
Penicillium spp	"	0	2×10^4	1×10^4
Aspergillus spp	"	46×10^4	34×10^4	33×10^4
Rhizopus spp	Soil 0–5 cm deep	0	1×10^4	–
	Soil 5–10 cm deep	0	0	–
	Soil 10–15 cm deep	0	0	–
Penicillium spp	Soil 0.5 cm deep	0	6×10^3	—
	Soil 5–10 cm deep	2×10^3	7×10^3	—
	Soil 10–15 cm deep	1×10^3	11×10^3	—
Aspergillus spp	Soil 0–5 cm deep	1×10^3	45×10^3	—
	Soil 5–10 cm deep	1×10^3	33×10^3	—
	Soil 10–15 cm deep	1×10^3	21×10^3	—

Rate of dung breakdown has been closely related to the weather conditions prevailing after deposition. Wet and warm conditions have been known to accelerate the disappearance rate. It is of interest to note that for the ecosystem under study a higher rate of disappearance during the dry and warm season was observed. In the temperate ecosystems, temperature and not moisture would be the limiting factor, and, therefore, increases in temperature at a particular season would enhance the degradation. The reverse holds for the derived savanna zone where the high temperature regime, in absence of moisture, will quickly dry up the dung. The dried up dung is more amenable to termite than to microbial degradation. The results indicate that the rate was faster with termites than with the micro-organisms. Though these termites are commonly found in the tropics, they are at times absent in some locations. It is therefore, suggested that two patterns of dung degradation are obtain in this region. In the first, the macroarthropods, especially *Isoptera* and *Coleoptera* spp., are the main agents of degradation during the dry season, which case the dry season rate of degradation will be greater than the wet season's. In the second situation, the biotic community does not have these termites during the dry season; therefore, the rate of breakdown during the wet season will be greater than during the dry season. In this second situation, other micro- and macro-arthropods are responsible for the dung breakdown, while in some instances, parts of the dung remain till the next wet season, when they are re-wetted and degraded by the coprophilous fungi. The rate of breakdown in such an ecosystem is invariably very slow. In the present study the peak dung accumulation occurred in the wet season, due mainly to the reduced rate of breakdown as well as increased size and number of voidings. However, the wet season was also the period of maximum herbage production and this enabled the grazing animals to retain productivity as the herbage available was still sufficient for this despite the fouling of some parts of the paddock.

A total of 0.38% of the herbage was estimated fouled per year. This value was less than estimates made in temperate pastures (Marsh and Campling 1970, Castle and MacDaid 1972). This value would even appear to be over estimated as the cows were observed to have always removed the tips of herbage growing in the dung pat area. Increasing grazing pressure has been reported to reduce rejection of the fouled herbage (Norman and Green 1958, MacLusky 1960, Greenhalgh and Reid 1969). This was confirmed in the present study. With little herbage available during the dry-season, fouled herbage was grazed during the second aftermath grazing, while during the wet season when more herbage was on offer this ws delayed beyond the same 12-week period. When the herbage available to the livestock was kept similar for the two seasons, this seasonal effect was lost. Rejection of fouled herbage could be of value in improvement of derived savanna range. In other ecological zones within the country, range improvement has proceeded successfully through feeding livestock with seeds of selected spp, especially the legumes, which on being voided in the dung at the area being improved will grow and develop (Foster 1961). Rejecting the dung area for sometime will enable the newly introduced species to establish properly before being grazed.

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