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EFFECT OF HARVESTING INTERVAL AND N-FERTILIZER APPLICATION ON THE GROSS ENERGY, DIGESTIBILITY AND CRUDE FIBRE CONTENT OF FIELD SWARDS

W. UBI and C. P. E. OMALIKO

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ABSTRACT

Effects of four levels of N fertilizer application and six intervals between harvests on field swards of Northern gamba grass, (*Andropogon gayanus*), Guinea grass c.v. s112, (*Panicum maximum)* and star grass (*Cynodon Polystachyus*) were studied over 30 weeks period in 1986. There was a significant ($P < 0.05$) increase in gross energy (GE) content by increasing N application and much more increases by increasing interval between harvests. For the three species, highest GE/kgN applied was obtained with 150kgN/ha-1 than with 0kgN/ha/yr or 450kgN/ha/yr. Harvesting frequencies and N application exerted a significant effect on the digestible organic matter (D-value). This study has established that the stage of growth in field swards has great influence on D-value and the main scope of improving the D-value would be to harvest every 4, 5 and 6 weeks for star grass, guinea grass and northern gamba grass respectively. The crude fibre content of herbage was increased by increasing interval between harvests but dropped consistently for every unit of 150kgN/ha-1 applied.

KEY WORDS: Nitrogen fertilizer, harvest intervals, Gross Energy, Digestibility and fibre of field swards

INTRODUCTION

Northern gamba, (*Andropogon gayanus*), Guinea grass c.v. s112 (*Panicum maximum*) and star grass (*Cynodon polystarchyus*) were among some Nigerian grasses found to be of good performance. Some investigations have been conducted with these and many other trpical and temperate species to test the influence of interval between harvests and N application on the degiestible dry matter, (D – value), the gross energy (GE) and the percent crude fibre (CF) content of herbage (Reid *et al*, 1959; Oyenuga, 1960a; Ademosu 1973; Omaliko, 1980; Munoz *et al*, 1983; Minson and Milford, 1987; Warren, J. M. (2000), Adesogan *et al* 1998, and Field *et al*, 1999).

Similarly, Minson and Milford, (1987) found that the low protein content of certain tropical grasses may limit the activity of the rumen microflora and hence reduce digestibility.

Forage crops are grown to provide digestible energy and other nutrients for livestock, particularly ruminants. The crop is a means of converting the seasonal inputs of light energy and soil nutrients into forage of high nutritive value and hence into animal product. (Munoz *et al*, 1983).

The first pre-requisite is usually the maximum production of digestible energy, but the content of other constituents required will depend on the management system. One of the most important characteristics of herbage is its digestibility, since this determines not only the proportion of the herbage which can be used by the animal, but also markedly affects its intake.

Enough work especially on the GE and CF content of herbage has not been done. In consideration of the fact that efficiency in protein utilization by the livestock is energy dependent has created the need to investigate further the best management system of field swards that will give a striking balance between quantity and quality for our livestock industry, using treatment combinations.

The objectives of this study were to determine the harvesting frequency in the growing season and the level of N-fertilizer that would give good quality herbage throughout the growing season.

MATERIALS AND METHODS

The experiment was conducted in 1986 using swards of the three grasses established in April, 1985 on the University of Nigeria farm at Nsukka on the fine loan soil of the Nkpologwu series.

The trial was planted in a 3 x 4 x 6 split-split-plot in a randomized complete blocks (RCB) design and replicated three times. The main plot treatment consisted of three grass species, the sub-plots were the N-fertilizer rates and the harvesting intervals as the sub-sun-plots. There were thus 9 main plots (species), 36 sub-plots (fertilizer rates) and 216 sub-sub-plots (harvesting intervals). Plot size was 3 x 48m sub-plot size was 3 x 12 m and sub-sub-plot size was 3 x 12 m. An area of $2m^2$ at the centre of each sub-sub plot unit was marked and harvested as sample. The three species of grasses used were: Northern gamba grass (*Andropogon gayanus*). *Panicum maximum*), guinea grass c.v. S112 and Star grass *Cynodon polystachyus*. Vegetative propagules of each species were planted at 25cm by 25cm spacing within and between rows, and were symbolized: Ngg, Gg and Sg.

The four different levels of N – fertilizer in the form of Urea were: 0, 150, 300 and $450kgN/ha^{-1}$. Six harvesting intervals were adopted – cutting either 3, 4, 5, 6, 8 and 10 weeks after planting during the growing cycle, and these intervals were symbolized H3, H4, H5, H6, H8 and H10.

A sub-sample of 500g was collected and wrapped in newsprint and dried at a temperature of 7^0C for 72 hours in a Gallen Kamp forced air laboratory oven, and then ground in a Thomas Willey laboratory model 4, using a 5mm mesh screen. The miled samples were then thoroughly mixed and stored in cellophane bags under dry room condition for use in chemical analyses.

Determination of organic matter Digestibility in dry matter was done with 200mg (+/- 1mg) sample, using pepsin in cellulose soluble method of Jones and Hayward, (1975). The gross energy value of herbage was determined with 2g sample by using a bomb calorimeter. The percentage crude fibre was determined by the use of crude fiber extractable apparatus according to AOAC (1980) method.

W. UBI, University of Nigeria, Nsukka, Nigeria. **Present address:** Ministry of Agriculture, 3 Barracks Road, Calabar, Nigeria
C. P. E. OMALIKO, University of Nigeria, Nsukka, Nigeria.

STATISTICAL ANALYSIS

Data were subjected to analysis of variance employing Fisher's Least Significant Difference (LSD) at 5% level to compare means (Little and Hills, 1977).

RESULTS

The main effect of treatment interactions on the digestible organic matter in dry matter (D-Value) of total herbage over 30 weeks period in this study is presented in Tables 1a and b. There was a significant ($P<0.05$) reduction in D-Value with extension of interval from 3 to 6 weeks and a further significant reduction with extension of interval from 3 to 6 weeks and a further significant reduction with extension from 6 to 10 weeks in the three species during the growing season. Cutting every 3, 4 and 5 weeks rather than 6, 8 and 10 weeks significantly ($P<0.05$) increased the D-Value of herbage in the three species during the growing season. On the average, the highest D-Value of 75.3% was obtained from plots cut every 3 weeks and was significantly greater than 54.2% obtained from plots cut every 10 weeks.

The effect of N application on D-Value of herbage was significant ($P<0.05$). There was a 8.1% (61.2 – 56.6) unit drop in D-Value when N was increases from 150Kg/N/ha^{-1} to 300Kg/N/ha^{-1} and a further 10.9% (56.6 – 51.0) unit drop in D-Value when N was increased from 300Kg/N/ha^{-1} to 400Kg/N/ha^{-1} (Table 1b). There was a progressive reduction in D-value when N-rates increased from 150Kg/N/ha^{-1} to 450Kg/N/ha^{-1}. The negative effect of applied N on D-Value was observed in the three species in which the application of 450Kg/N/ha-1 tended to produce the least D-Value compared with 0Kg/N/ha^{-1}. Thus, species x Nitrogen interaction in terms of D-Value was significant, with Ngg recording the highest D-Value at any given level of N-treatment than either Gg or Sg.

The effect of species x harvesting interval on Gross Energy (GE) value of herbage is presented in Table 2. Increasing the interval between harvests, from a 3 to 4 and 5 to 6 or 8 to 10 weeks significantly ($P<0.05$) increased the GE value of herbage in the three species during the growing season. The mean GE values of the species were not significantly different, but the species produced their maximum GE value from plots where no N was applied. The N x SP interaction in respect of GE value was not significant.

TABLE 1a EFFECT OF SPECIES X HARVESTING INTERVALS ON % D-VALUE OF HERBAGE, OVER 30 WEEKS IN 1986

Mean of 4 N Levels

Species	Harvesting Intervals (Weeks)						Species Mean
	3	4	5	6	8	10	
Ngg	79.8	74.1	71.9	70.2	61.6	57.4	68.7
Gg.	76.7	66.9	66.5	60.7	55.6	54.6	61.5
Sg.	69.8	55.1	54.4	50.9	44.4	44.1	50.6
Mean	75.3	65.4	64.2	60.6	56.9	54.2	

LSD (0.05) between treatment means

Species	0.8
Harvest	1.2
Species x Harvest	2.1

TABLE 1b: EFFECT OF SPECIES X NITROGEN ON % D-VALUE OF HERBAGE, OVER 30 WEEKS IN 1986

(Mean of 6 Harvesting Intervals)

Species	NITROGEN RATES (Kg/ha^{-1})				Species Mean
	0	150	300	450	
Ngg	68.4	61.2	56.6	51.0	59.3
Gg.	62.6	58.1	52.5	47.4	55.1
Sg.	58.1	51.4	48.3	41.3	49.7
Mean	63.0	56.7	52.4	46.5	

LSD (0.05) between treatment means

Species	2.4
Nitrogen	3.1
Nitrogen x Species	4.2

TABLE 2: EFFECT OF SPECIES X HARVESTING INTERVALS ON GROSS ENERGY VALUE (103 Kcal) OF HERBAGE OVER 30 WEEKS IN 1986

(Mean of 4 n-Levels)

Species	(Harvesting Intervals (Weeks)						Species Mean
	3	4	5	6	8	10	
Ngg.	2.56	2.78	2.89	3.06	3.33	3.49	3.02
Gg.	2.52	2.94	3.03	3.10	3.39	3.59	3.10
Sg.	2.78	3.09	3.16	3.30	3.58	3.64	3.26
Mean	2.62	2.93	3.02	3.15	3.43	3.57	

LSD (0.05) between treatment means

Species	0.06
Harvest	0.12
Species x Harvest	0.15

TABLE 3a: EFFECT OF INTERVAL BETWEEN HARVESTS AND NITROGEN FERTILIZER ON % CRUDE FIBRE OF HERBAGE OVER 30 WEEKS

Mean of 4 N – Fertilizer Levels

Species	Harvesting Intervals (Weeks)						Species Mean
	3	4	5	6	8	10	
Ngg	10.5	12.2	15.1	19.1	20.4	22.2	16.8
Gg.	10.8	14.7	16.4	19.3	21.0	23.1	17.6
Sg.	15.5	16.2	19.6	24.2	28.3	29.7	21.8
Mean	11.3	15.0	17.4	20.1	23.2	25.0	

LSD (0.05) between treatment means

Species	0.8
Harvest	1.2
Species x Harvest	2.0

TABLE 3 b: EFFECT OF SPECIES X NITROGEN FERTILIZER ON CRUDE FIBER CONTENT OF HERBAGE OVER 30 WEEKS

(Mean of 6 Harvesting Intervals)

Species	N – FERTILIZER RATES (KGW/HA				Species Mean
	0	150	300	450	
Ngg	10.5	13.2	18.5	20.5	15.7
Gg.	11.6	14.1	19.3	22.2	11.3
Sg.	16.2	17.4	21.3	24.4	20.2
Mean	12.7	15.2	19.8	22.4	

LSD (0.05) between treatment means

Species	1.4
Nitrogen	1.8
Species X Nitrogen	4.2

The crude fibre content of the herbage was highly influenced by the treatment combinations, (Table 3a and b). There was a highly significant ($P < 0.05$) increase of 8.2% CF on the average, when intervals between harvests increased from a 3, 4 and 5 weekly cut to a 6, 8 and 10-weekly cut. Star grass gave the highest CF content of 21.8% on the average and was significantly ($P<0.05$) greater than that of either guinea or northern gamba grass using treatment combinations, during the growing season.

DISCUSSION

The reduction in D-Value due to increase in interval between harvests found in this study had been reported by several investigators, (Hardison, 1959; Walker, 1959; Haggar and Ahmed, 1970; Adesogan *et al* 1988, Field *et al*, 1999.

In this study, there was a drop in D-Value when interval between harvests was increased from 3, 4 to 6-weekly cuts, and a more significant drop from 6 to 10-weekly cuts in the three species. In a similar experiment, Ademosun, (1973), reported that digestibility of most components of herbage declines significantly from the first cut at 4 weeks to the second cut at 7 weeks.

Sp x H interaction in this experiment showed that cutting each species every 3 weeks on the average had D-value of 75.3 compared with 54.2 recorded with herbage cut every 10 weeks; and agrees with the reports of Reid *et al* (1959) that the main scope for improving forage digestibility would be earlier harvesting. The stage of growth has great influence on digestibility which is adversely affected as grass matures, partly because the proportion of cell wall material increases and partly because of higher proportion of 'stem'. The greater part of the energy furnished by forage is derived from the carbohydrates, the value of which depends both on their quantity and on their digestibility. As the efficiency of utilization of the energy of the longer chain acids (from the readily digestible carbohydrates) will be greater than that of acetic acid (from the rumen), thus forages rich in soluble carbohydrates may be utilized more efficiently than those which favour acetic acid but the range in efficiency may not be great. In this study, the highly significant D-value of northern gamba over other species is due to the succulent nature of this species with highly digestible cytoplasmic materials. The low D-value reported for the three species at prolonged intervals and high levels of N, obtained in this study may be attributable to two factors; the maturity of the cytoplasm at plant maturity and liquification, making herbage less digestive.

In this study, it was found that the significant increases in the GE and CF contents of herbage due to increasing intervals between harvests and N-rates are in agreement with the report of Hardison (1959); and Oyenuga, (1960). The sum of the crude fibre in the forage represents the major portion of carbohydrate in the feed, while the energy is important in the support of the efficient utilization of protein in the ration, a concept known as calorie/protein ratio. For an animal to utilize much of protein in the ration, it requires a specific amount of energy.

CONCLUSION

The use of nitrogen fertilizer is essential in present day forage management if the farmer is to continue to provide adequate production for the livestock industry. The stage of maturity at which the forage is harvested is very important in determining the quality of herbage because the quality of herbage deteriorated with plant maturity. In order to strike a balance between quantity and quality, harvesting every 4, 5 and 6 weeks for northern gamba, Guinea and Star grasses and fertilizing at 300KgN/ha^{-1} are suggested as good management practices that would greatly increase forage production and maintain much more productive stand for longer periods of time.

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