GLOBAL JOURNAL OF PURE AND APPLIED SCIENCES VOL. 12, NO. 3, 2006: 295 - 300
 ISSN 1118 - 0579

EFFECT OF HARVESTING INTERVAL AND NITROGEN APPLICATION ON TILLER HEIGHT, NUMBER OF GREEN AND DEAD LEAF BLADE PER TILLER IN FIELD SWARDS

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(Received 29 September, 2005; Revision Accepted 24 May, 2006)

ABSTRACT

Two experiments were conducted in July 2000 and in March 2001 at Iwuru, Biase, 15 km from Akamkpa Campus of Cross River State University of Technology, Nigeria to estimate the effect of harvesting intervals (2, 3, 4, 5, 6, and 8 weeks) and nitrogen fertilizer application (0, 100, 200, and 300kgN/ha) on tiller height, number of green and dead leaf blade per tiller of Northern gamba (Ngg), Guinea grass (Gg) and Star grasses (Sg). Increasing delay in date of harvesting and increasing nitrogen fertilizer application significantly ($P < 0.05$) exerted a positive effect on tiller height, number of green and dead leaf blades per tiller in field swards. Highest height of 113.6 and 116.1 cm were obtained in plots cut every 8 weeks treated with 300kgN/ha in 2000 and 2001 respectively. Highest number of green leaf blade on the average occurred in plots cut every 3, 4, 5 and 5 weeks for Ngg Sg, and Gg respectively compared with other treatments. Applied N retarded leaf death early in the season and accelerated death and delayed flowering subsequently, later in the season. Delaying cutting reduced number of green leaf blades but increased tiller height. Highest number of dead leaf blades occurred in the 8 weekly cut plots where 300kgN/ha was applied and lowest in the 2-weekly cut plots where N was not applied. Ngg had the highest number of green leaf blades and dead leaf blades on the average and was significantly ($P < 0.05$) higher than either those of Gg or Sg during the season. These results are discussed in relation to field swards management during the study period.

KEYWORDS: Harvesting Interval, N-fertilizer rates, tiller height, number of green and dead leaf blades, field swards

INTRODUCTION

Grasses such as Northern gamba grass (*Andropogon gayanus*), Guinea grass C.V. S112 (*Panicum maximum*) and Star grass (*Cynodon polystarchyus*) are adopted to a wide range of soils in the Savanna Zone of Nigeria. Their effective use for grazing and hay has been due to their high productivity and quality. Generally, studies have been conducted with these and other temperate species to estimates the influence of cutting frequencies and nitrogen levels on yield and yield components (Omaliko 1980; Pearse and Wilman 1984; Wilman and Pearse 1984; Woosehouse 1992; Ubi and Omaliko 2004, Ubi and Ique 2005) Information regarding cutting frequencies and nitrogen levels on tiller growth and green leaves and dead leaf census had not been sufficient.

Leaves contain most of the plant protein and minerals, have most of its highly digestible dry matter and are low in fiber in comparison to stem. The number of green leaf blade per tiller in a particular grass species places high value on this species in terms of animal nutrition. Certain treatments such as management system and N- rates could be used to improve the leaf quality and quantity. Wilman and Pearse (1984) noted that an increase in the interval between harvest allowed a larger positive response of applied N to develop in respect of tiller and leaf growth and development.

The objectives of this study are to determine the harvesting frequency and also N-fertilizer rate that would give the highest number of green leaf blades when the tiller attains a certain height, for good quality herbage throughout the growing season.

MATERIALS AND METHODS

Two experiments were conducted in July 2000 and March 2001, using swards of grasses established in March 2000 on a nearly level field, at Iwuru. Iwuru lies between 8^0 14' and 8^0 20 'E longetitude and 5^0 14' N and 5^0 18'N latitude with a rainfall of over 2000mm in the rain forest vegetation of the basement complex soil. The soil consists mainly of schrists, quartzites and marble with a sandy surface horizon and a developed clayey, mottled and occasionally conceretionary sub-soil (FAO, 1966). The area was previously cropped with cassava, followed by a five year fallow in which *Maximum* (Guinea grass) was the dominant fallow species. The site was manually cleared with matchet, stumped, and allowed to dry for some days then gathered together and removed.

Table 1: Rainfall values from 1999 to 2001

Months	1999/2000 Average Rainfall (mm/day)	2000/2001 Average Rainfall (mm/day)	
January	4.5	4.3	31.0
February	86.6	9.1	34.1
March	65.4	64.0	36.0
April	52.1	32.5	41.3
May	89.6	91.4	35.2
June	112.4	103.6	34.4
July	84.5	89.2	33.6
August	69.7	73.4	32.1
September	71.2	56.0	33.0
October	34.0	47.1	31.2
November	22.6	24.8	30.5
December	11.4	6.1	29.7
Mean	52.2	50.1	33.5

Source: Meteorological Station, College of Education, Cross River State University of Technology, Akamkpa Campus

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There were 6 frequencies of harvest namely: 2, 3, 4, 5, 6 and 8 weeks. There were 4 N levels of urea fertilizer applied at the rates of 0, 100, 200 and 300kgN/ha-^{1}.
The trial was conducted in a 3 x 4 x 6 split-split-plot in a randomized complete block (RCB) design, replicated three times. The main plot treatment consisted of three grass species, the sub-plots were the fertilizer levels and the sub-sub-plots were the intervals between harvests.
There were 9 main plots (species), 36, sub-plots (fertilizer rates) and 216 sub-sub plots (harvesting intervals). Plot size was 4m x 48m, sub-plots size was 3m x 12m and sub-sub-plot size was 3m x 6m.

Tiller heights (cm) were taken by measuring heights of three tillers, randomly selected from within each plot to be harvested. Measurement was in-situ from tiller base to the leaf blade tip, and sampling was done along the diagonals of each plot to be harvested. A set of ten tillers were randomly harvested and separated into green leaf blades and dead leaf blades. A leaf was regarded green when it had over 50% of its length green while blades with less green tissue were regarded as dead leaf blades.

Statistical Analysis
Data was subjected to analysis of variance (ANOVA) and means compared with Fisher's Least Significant difference (LSD) at 5% level.

RESULTS

The results of species x harvesting interval on tiller height (cm) (mean of 4N levels) is presented in table 2. Harvesting frequencies affected tiller height such that tiller height on the average, significantly ($P < 0.05$), increased with increasing harvesting interval from 28.3cm for a 2- weekly interval to 94.4cm for a 8 - weekly interval in 2000. During the 2001 planting season, tiller height (cm) increased from 28.5cm for a 2- weekly interval to 96.2 (cm) for a 8 – weekly interval. There was a 122.5% (36.0- 80.1) cm unit increase in 2000 and a 120.2% (35.7- 78.6)cm unit increase in 2001 when cutting intervals increased from a 2, 3, and 4 weeks to a 5, 6 and 8 weeks. Doubling the interval between harvests from 2, 3, and 4 - weekly cuts to 5, 6, and 8 weekly cuts significantly doubled tiller height in the three species. This indicates that growth was more restricted in frequently cut plots but was fully expressed in the prolonged intervals throughout the growing season.

Table 2: Effect of species and harvesting intervals on tiller height (Cm) (Mean of 4N Levels)

	Harvesting of intervals (weeks)						
Species	2	3	4	5	6	8	Species Mean
				2000			
Ngg	35.5	46.6	51.3	80.1	120.0	124.4	76.3
Gg	33.1	40.1	47.7	60.9	98.1	104.8	64.1
Sg	16.3	23.9	29.7	36.2	42.0	54.1	33.7
Mean	28.3	36.9	42.9	59.1	86.7	94.4	
				2001			
Ngg	36.3	46.7	51.7	7.9	120.4	126.3	76.9
Gg	32.5	38.0	47.0	47.9	96.1	107.0	63.0
Sg	16.3	28.1	30.4	36.7	41.8	55.4	33.9
Mean	28.5	35.6	43.0	54.6	85.1	96.2	

LSD (0.05) between treatment means	2000	2001
Species	3.4	3.3
Harvesting intervals	4.1	4.0
Harvesting Interval x Species	4.8	4.7

Cutting any of the three species every 8 weeks gave the highest tiller height during the season. The data on harvest x nitrogen interaction presented in table 3 clearly show the significant effect of the treatments on tiller height. Highest heights of 113.6 (cm) and 116.1 (cm) for 2000 and 2001 were obtained in plots cut every 2 weeks, where no N was applied.

The Sp x N interaction in respect of tiller height (cm) was significant ($P< 0.05$) Table 4). There was a 8.6% (55.7-60.5)cm unit increase in tiller height in 2000, and a 11.9% (54.3 – 60.3)cm unit increase in 2000 and 17.7% (60.8 – 71.6) unit increase in 2001 when N - rate was increased from 200kgN/ha to 300kgN/ha. Height increases of tillers was accelerated by high levels of N – application, such that the three species obtained their maximum heights where 300kgN/ha was applied compared with other treatments.

The interaction of species x harvesting interval in respect of number of green leaf blade per tiller is presented in Table 5. Increasing intervals between harvest significantly ($P<0.05$) influenced the number of green leaf blade per tiller. The three species differ significantly ($P<0.05$) in terms of number of green leaf blade, but the species produced their maximum green leaf at different harvesting intervals. The highest number of green leaf blade was obtained by cutting Ngg every 3 weeks and was significantly ($P < 0.05$) higher than that obtained under any of the other intervals within the three species. Cutting Ngg every 3 weeks, Sg every 4 weeks and Gg, every 5 weeks gave the highest yield of green leaf blade.
The response of the three species to harvest intervals x nitrogen in terms of number of green leaf per tiller is presented in Table 6. In 2000, highest number of green leaf blade (8.9) was obtained from a 5 - weekly cut plot where 200kgN/ha was

Table 3: Effect of harvesting interval and nitrogen on tiller height (cm) (Means of 3 species)

Nitrogen	Harvesting interval (weeks						
N rates kg/ha)	2	3	4	5	6	8	Nitrogen Mean
			2000				
0	18.8	28.1	35.7	41.7	69.9	75.3	44.9
100	26.5	32.8	38.9	53.6	82.2	90.5	55.7
200	37.0	36.6	49.2	63.5	86.8	98.3	60.5
300	36.8	47.2	51.7	77.5	104.5	113.6	71.8
Mean	27.8	36.2	43.9	59.1	85.9	94.4	
			2001				
0	18.9	27.5	35.7	41.6	70.2	76.3	45.0
150	26.8	31.5	30.9	54.7	81.8	91.0	54.3
300	30.6	37.3	46.2	61.4	88.5	100.7	60.7
450	37.2	46.1	51.4	74.9	103.8	116.1	71.6
Mean	28.4	35,6	43.1	58.2	86.1	96.3	

LSD (0.05) between treatment Means	2000	2001
Harvest	2.2	2.3
Nitrogen	2.4	2.5
Harvesting interval x Nitrogen	3.1	3.2

Table 4: Effect of Species and Nitrogen on tiller height (cm) (Means of 6 Harvesting intervals)

	2000				
Species	Nitrogen levels (kg/ha)				
	0	100	200	300	Species
Ngg	63.2	71.9	77.0	92.9	76.3
Gg	50.2	61.3	69.4	76.3	64.1
Sg	21.4	34.0	35.0	46.2	33.7
Mean	44.9	55.7	60.5	71.8	
	2001				
Ngg.	63.3	72.3	78.0	93.9	76.9
Gg	49.8	61.0	67.0	74.2	63.0
Sg	22.0	29.5	37.3	46.6	33.9
Mean	45.0	54.3	60.8	71.6	

LSD (0.05) between treatment Means.	2000	2001
Species	2.1	2.0
Nitrogen	2.6	2.5
Species x Nitrogen	3.0	3.1

Table 5 : Effect of species and harvesting intervals on number of green leaf/ tiller (Mean of 4 N levels)

Species	Harvesting intervals (weeks)						
			2000				
	2	3	4	5	6	8	Species Mean
Ngg	4.6	9.0	6.8	6.5	6.3	5.0	6.3
Gg	4.5	4.6	6.0	7.2	5.6	4.8	5.4
Sg	4.4	4.7	6.0	4.9	5.0	4.2	4.8
Mean	4.5	6.1	6.3	6.2	5.6	4.6	
				2001			
Ngg	5.7	6.9	6.8	6.3	6.4	5.2	6.5
Gg	4.1	4.3	5.8	6.9	5.4	4.9	5.2
Sg	4.0	4.1	6.1	5.2	5.1	4.4	4.8
Mean	4.6	5.7	6.2	6.1	5.6	4.8	

LSD (0.05) between treatment means	2000	2001
Species	0.04	0.04
Harvest	0.06	0.06
Species x Harvest	0.08	0.08

applied and was significantly (P<0.05) higher than 3.6 obtained from a weekly cut plot were no N was applied.

During the 2001 growing season, highest number of green leaf blade 98.8) was applied from a 5 – weekly cut plot where 200kgN/ha was obtained and was significantly (P <0.05) higher than 3.7 obtained from plots cut every 2 weeks where no N was applied. On the average, green leaf blade obtained in plots that received 200kgN/ha (6.7 in 2000 and 6.6 in 2001) was significantly higher than that obtained under any of the other treatments (Table 6).

The response of species x harvesting intervals on the number of deaf leaf blade per tiller is presented in Table 7. Delaying cutting significantly (P < 0.05) increased number of dead leaf blade. There was a 25.9% (3.6 – 4.5) unit increase in dead leaf blade each for 2000 and 2001 when cutting intervals increased from a 2, 3, and 4 weeks average to a 5, 6 and 8 weeks average. The three species differed significantly (P < 0.05) in terms of number of dead leaf blade per tiller. The results showed that Ngg produced equal number of blades (14.7) in 2000 and 2001 and was significantly higher than those of either Gg or Sg.

Table 6: Effect of harvesting interval and nitrogen on number of green leaves/tiller, (Mean of 3 species)

Nitrogen (rates kg/ha)	Harvesting intervals (weeks)						
	2000						
	2	3	4	5	6	8	Nitrogen mean
0	3.6	4.8	5.0	5.6	4.6	4.3	4.6
100	4.8	5.9	6.4	6.8	5.4	4.6	5.6
200	5.6	6.7	7.0	8.9	6.6	5.4	6.7
300	4.8	5.8	6.4	6.8	5.5	4.6	5.6
Mean	4.7	5.8	6.2	7.0	5.5	4.7	
	2001						
0	3.7	4.7	4.9	5.4	5.1	4.2	4.6
100	4.9	5.8	6.3	6.9	5.3	4.6	5.6
200	5.6	6.6	7.2	8.8	6.4	5.3	6.6
300	4.8	5.7	6.4	6.8	5.4	4.6	5.6
Mean	4.7	5.7	6.2	6.9	5.5	4.6	

LSD (0.05) between treatment means

	2000	2001
Nitrogen	0.2	0.2
Harvest	0.3	0.3
Nitrogen x harvest	0.4	0.4

Table 7: Effect of species and harvesting intervals on number of dead leaves/tiller) (Mean of 4N Levels)

Species	Harvesting of intervals (weeks)						Species Mean
	2	3	4	5	6	8	
	2000						
Ngg	4.0	4.3	4.4	4.4	5.3	6.1	4.7
Gg	3.1	3.3	4.0	4.1	4.3	4.6	3.9
Sg	3.0	3.2	3.6	3.8	4.1	4.2	3.6
Mean	3.3	3.6	4.0	4.1	4.5	5.0	
	2001						
Ngg	4.1	4.2	4.4	4.5	5.4	5.8	4.7
Gg	3.2	3.4	4.3	4.4	4.8	4.7	4.1
Sg	3.1	3.3	3.5	3.7	4.0	4.3	3.6
Mean	3.4	3.6	4.0	4.2	4.6	4.9	

LSD (0.05) between treatment means

	2000	2001
Species	0.04	0.04
Harvesting intervals	0.06	0.05
Harvesting Interval x Species	0.08	0.08

The interaction of harvest interval x nitrogen in respect of number of dead leaf blades is presented in Table 8. The highest number of dead leaf (7.1 in 2000 and 6.6 in 2001) occurred in plot cut every 8 weeks where 300kgN/ha was applied and this was significantly ($P < 0.05$) higher than that obtained under any of the other intervals and N – rates. The number of dead leaf blades was significantly ($P < 0.05$) increased by every addition of 100kgN/ha, throughout the study period. The death of leaf blade was reduced by applied N, early in the season and subsequently accelerated by applied N, later in the season.

DISCUSSION

Tiller height, and number of green leaf blade are some of the measures of crop growth which usually influence the amount of dry matter yield. Increased tiller height in this study was due to prolonged harvesting interval. In a similar study, (Wool House 1992) reported an increase in tiller height due to delayed cutting.

Akintola et. al. (1971) found that seasonal variations in tiller was less pronounced in plots harvested more often with a

Table 8: Effect of harvesting intervals and nitrogen on number of dead leaves/tiller (Means of 3 Species)

Nitrogen Rates kg/ha)	Harvesting interval (weeks) 2	3	4	5	6	8	Nitrogen Mean
			2000				
0	3.0	3.2	3.3	3.4	4.5	4.7	3.6
100	3.1	4.0	4.1	4.3	4.4	5.1	4.2
200	4.0	4.2	4.3	4.5	5.4	5.6	4.7
300	4.0	5.6	5.8	6.4	6.6	7.1	5.9
Mean	3.5	4.3	4.4	4.7	5.2	5.6	
			2001				
0	3.0	3.2	3.3	3.3	4.5	4.6	3.6
100	3.1	4.1	4.2	4.2	4.3	5.2	4.2
200	4.1	4.3	4.4	4.6	5.4	5.5	4.7
300	5.0	5.1	5.2	6.1	6.3	6.6	5.7
Mean	3.8	4.2	4.3	4.6	4.8	5.1	5.5

LSD (0.05) between treatment Means.

	2000	2001
Harvest	0.05	0.05
Nitrogen	0.08	0.08
Harvesting interval x Nitrogen	0.15	0.14

33.0% increase in average tiller height from 37.5cm to 50.0cm by harvesting cynodon strain at six weeks rather than four weeks interval, and is in agreement with the findings in this study. The result of this study showed that nitrogen fertilizer application increased tiller height and is consistent with the results of (Wilman and Pearse 1984; Pearse and Wilman 1984; Chheda and Akintola 1971), that N application exerts a significant effect on tiller growth and development.

The early response of species to treatment combinations in the present experiment was particularly striking. The positive effect of applied N on number of green leaf blade coupled with its retarding senescence in the early stage after application, led to a significant effect in net gain in number of green leaf blade early in the season. In addition, applied N had increased the size of green leaf blades within a few days of application, in line with the reports of (Wilman and Pearse 1984; Ryle 1984) . The area of photosynthesis per unit area of leaf would also be increased by applied N in the early stages of regrowth.

The present results suggest that applied N may tend to have the reverse effect in larger, older tillers. The positive effect of applied N on the number of green leaf blade that emerged per tiller in this study is in agreement with the earlier results of (Wilman and Wright 1993).
From this study of senescence and dead tissue tended to be retarded by applied N, and subsequently tended to increase later in the season. The change from N reducing death of leaf blades earlier in the season to N increasing death of leaf blades occurred at different times as reported by Wilman *et al* (1976); Wilaman and Martius, (1977); and Oyenuga (1960) Taking the average of 8 weeks, period of study, applied N increased the amount of dead leaf blade, and when there was succession of N application and harvest during the season, the total area of leaf blade per hectare which died was certainly increased by applied N.

Evidently, Ngg has a faster rate of leaf turn over, than Gg and Sg, and rather more leaves per tiller, this definitely might have accounted for Ngg having the greatest number of green leaves and dead leaves.

It is suggested that in leaf aging, the life-potential of the individual cells is not exhausted, but that changes are brought about under the influence of stimuli coming from other parts of the plant. By this implication, senescence in N – deficient grass is to some extent premature and N is withdrawn from the older leaves even before full expansion when N is ample, the whole rate of plant activity, including leaf turn over is accelerated and this effect soon overrides the effect N can have in retarding senescence especially when the effect of N in increasing leaf size has been carried through the dying leaves.

Green leaves are very important either as a life plant or as herbage. The number and size of green leaf blade per tiller at any given time contributes to the level of the nutritional quality and yield. N fertilizer application and a suitable management system can help improve this quality and yield. In this study, it has been found that harvesting Ngg very 3 weeks, Sg every 4 weeks and Gg every 5 weeks with the application of 200kgN/ha-^{1} is considered ideal for greater economic returns to the farmer and improvement of the livestock sector, noted by Omaliko (1980).

CONCLUSION

The results of this study have shown that establishing swards of different grass species with nitrogen application would guarantee extended harvesting periods. The essence of grass sward management is to strike a balance between quantity and quality and harvesting each species every 6 weeks, with the application of 200kgN/ha was found to be cost effective with good economic returns to the farmer.

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