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THE EFFECT OF INTERVAL BETWEEN HARVESTS AND N-FERTILIZER APPLICATION ON TILLER PRODUCTION AND YIELD ATTRIBUTES OF FIELD SWARDS

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ABSTRACT

Tiller population and yield attributes as influenced by interval of harvests (4, 6, 8, and 10 weeks) and N. fertilizer application (0, 100, 150 and 200kg Nha^{-1}) on field swards was investigated in April 2004 and 2005 using swards of grasses established at Iwuru in march, 2003. The results showed that both intervals between harvest and N-fertilizer application exerted significant effects on tiller production and yield attributes of each species of grass. On the average, there was 22.2% increase in the number of tillers produced for every increment of 50kg Nha^{-1}. Increasing interval between harvest consistently increased the number of tillers produced up to plots cut every 8 weeks with no further increase in plots cut ever 10 weeks. The species differed in their potentials for new tiller formation and regrowth. The pattern of response and number of tillers produced by northern gamba grass (Ngg) was significantly ($P<0.05$) higher than that of guinea grass (Gg) when given the same treatment. For every addition of 50kg Nha^{-1}, there was a corresponding increase in the dry matter yield (Dmy) of green leaves up to 150kg Nha^{-1} with no further increase in plots that had 200kg Nha^{-1} The dry matter yield of dead leaves and stem were increased by increasing interval between harvest and by increasing N-fertilizer application. The dry matter yield of inflorescence was not statistically significant. The implications of these results are discussed in light of field sward management.

KEYWORDS: Interval between harvest, nitrogen fertilizer, tiller production, yield attributes of field swards.

INTRODUCTION

Tiller production has been found to response quickly to changes in nitrogen supply (Wilman and Wright, 1994, Pearse and Wilman, 1984, Ubi and Omaliko, 2004) Grass species vary in their flowering pattern (Cooper, 1960; Bean, 1969) and this could be reflected in their tiller production pattern during regrowth.

Guniea grass (*Panicum maximum* C.V 112) a tufted perennial is one of the most important tropical grasses. It is utilized for grazing and preparation of hay and silage. Research work on both temperate and tropical grasses had been done on the agronomic assessment, especially on the responses of guiniea and northern gamba grasses to nitrogen application and cutting management (Langer, 1972; Davies, 1976; Ubi and Omaliko 2004; Ubi and Ique, 2005). They also found that the number of life tillers significantly influenced the grass canopy size and the total dry matter yield Swards under a 4-weekly cutting scheme received 400kg Nha^{-1} produced dry herbage yield of 14 0 t/ha^{-1}, which was 80% of the maximum of 17.3/ha^{-1} obtained with a 6-weekly interval with the application of 500kg Nha^{-1} (Langer, 1972, Davies, 1976)

In Nigeria, Ubi and Omaliko (2004) found that *Panicum maximum* has the highest growth rate and green leaf yield (70 t/ha^{-1}), when allowed a 12 weekly growth cycle. Wilman and Wright (1994) reported that the yield of green leaves of sown species was increased by extending the interval from 3 to 6 weeks where no N was applied. They also found that yield of dead leaves was increased by 12-fold when interval between harvest was increased from 3 to 20 weeks; and that doubling the interval between harvest increased yield of stem and inflorescence.

The purpose of the study was to determine the best interval between harvest and the nitrogen rate on tiller production in the two commonly grown grass species in Nigeria. Such information would be used to formulate a definite management system that would enhance productivity and profitability in field swards management.

MATERIALS AND METHODS

Two experiments were conducted on a nearly level field in April 15th 2004 and 2005 using swards of grasses established in March 2003 at Iwuru near Calabar Iwuru lies between 8°14 and 8°20'E longitude and 5°14'E and 5°18'E latitude with an annual rainfall of over 2000 mm in the forest vegetation on abasement complex soil. The area was previously cropped with cassava followed by a four-year fallow in which spear grass was completely eradicated by digging out the rhizomateous roots. The two grass species were. Northern gamba grass (*Andropogon gayanus*) symbolized (Ngg), and Guinea grass (*Panicum maximum*) symbolized (Gg) The four nitrogen levels used in the form of urea were: 0, 100, 150 and 200kg Nha^{-1} The four intervals between harvest were: 4, 6, 8 and 10 weeks from the first harvest.

The trial was conducted in a 2x4x4 split-split-plot in a randomized complete block design (RCBC), replicated four times. Plot size was 3m x 48m, sub-sub-plot was 3m x 24m, and the sub-plot size was 3m x 12m The sampling area was 3m x 6m The main plot treatment consisted of the two grass species, the sub-plots were the four fertilizer levels and the sub-sub-plots were the four cutting intervals.

All the grasses were cut back (clearing –cut) to 5cm height at the beginning of the experiment before treatments were applied. Equally, all plots were treated with single super phosphate (P_2O_5) and muriate of potash K_2O at the rates of 320kg P/ha and 122.1kg K/ha respectively The number of tillers that emerged were counted from the marked tillers and the average taken and recorded for each treatment.

A set of ten tillers were randomly harvested and separated into "stem", green leaf blades, dead leaf blades and inflorescence. A leaf was regarded green when over 50% of its length was green at harvest. The "stem" is the true stem plus leaf sheaths and part of inflorescence unemerged beyond the flag leaf. The fresh weight of the four components were taken, then dried at a temperature of 60°C for 48 hours in a Gallen kamp forced air laboratory oven and then weighed. The weight of each components was then divided by the sum of all

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components and multiplied by 100 and expressed each proportion as a percentage on dry matter bases. Yield of each component was determine and expressed in t/ha^{-1}

Another set of ten tillers were randomly selected within the sampling area, and marked at the based with a red ring wire for the study of tiller production

Statistical Analysis

Data were subjected to an analysis of variance (ANOVA) and means compared with Fishers Least Significant Different at 5% probability level deploying the methods of Wahau. (1999).

RESULTS

The results of tiller production due to the intervals between harvest of two grass species are presented in Table 1 The number of tillers significantly (P<0.05) increased consistently from the 4-weekly cut to the 8-weekly cut intervals and then dropped at 10-weekly cut interval for both grasses. The highest tiller production (36.0) was obtained from Gg in plots cut every 8 weeks in 2004 planting season while the lowest (12.0) was obtained from Gg in plots cut every 4 weeks during the 2005 planting season. Species differences in terms of number of tillers was significant with Ngg producing on the average, the highest tiller number (25.7 in 2004 and 24.5 in 2005), and these were significantly higher than averaged values obtained from Gg when given the same treatments. The two species, however, produced their highest number of tillers in the 8-weekly cut plots and their values were significantly (P<0.05) higher than all other values obtained from all other intervals. Thus the interval x species interaction was therefore significant (P<0.05).

Table 1: The effect of species and interval between harvest on the number of tillers produced per plot in two grass species during the 2004 and 2005 planting seasons

Means of four N-rates					
Harvesting interval (weeks)					
2004					
Species	4	6	8	10	Species Mean
Ngg	18 0	24.0	32.0	29 0	25.7
Gg	14.0	18.0	36.0	21.0	19.7
Mean	**16.0**	**21.0**	**29.,0**	**25.0**	
2005					
Ngg	17.0	26.0	29.0	26.0	24.5
Gg	12.0	15.0	21.0	18.0	16.5
Mean	**14.5**	**20.5**	**25.0**	**22.0**	

LSD (0.05) between treatment means

	2004	2005
Harvest Interval Means	3.2	2.6
Species Mean	4.6	5.8
Harvest Interval x Species Mean	5.2	6.4

Table 2: The effect of N-rates and species on tiller production of two grass species during the 2004 and 2005 planting season

(Means of 4 harvesting interval)					
	Nitrogen Rates (kgha)				Species Mean
Species	0	100	150	200	
2004					
Ngg	10.0	18.0	22.0	28.0	19.5
Gg	9.0	12.0	18.0	20.0	14.7
Mean	**9.5**	**15.0**	**20.0**	**24.0**	
2005					
Ngg	11.0	18.0	23.0	29 0	20.2
Gg	10.0	14.0	18.0	21 0	15.0
Mean	**10**	**160**	**20.0**	**250**	

LSD (0.05) between treatment means

	2004	**2005**
Nitrogen Means	3 8	3.9
Species Mean	4.6	4 5
Nitrogen x Species Mean	5 6	5 4

Table 3. The effect of interval between Harvest and N-fertilizer rates on tiller production (days) in two grass species, during the 2004 and 2005 planting season.

(Means of 2 species)					
Harvesting intervals (weeks)					
2004					
N-rate (kg/N/ha)	2	6	8	10	Nitrogen Mean
0	8.0	10.0	12.0	12.0	10.5
100	12.0	14.0			
150	16.0	18.0			
200	24.0	28.0			
Mean	**15.0**	**17.5**	**20.3**	**19.8**	
2005					
0	**7.0**	**9.0**	**13.0**	**12.0**	10 3
100	**12.0**	**14.0**	**15.0**	**16.0**	14.3
150	**15.0**	**17.0**	**22.0**	**21.0**	18 7
200	**23.0**	**25.0**	**31.0**	**30.0**	27.2
Mean	**14.3**	**16.2**	**20.2**	**19.8**	

LSD (0 05) between treatment means

	2004	2005
Interval Means	1 8	1 6
Nitrogen Mean	3 1	2 8
Interval x Nitrogen	4 2	4.1

The interactions of N-rates x species in terms of tiller production of two grass species are presented in Table 2. The increase in the application of nitrogen fertilizer from 100kg N/ha to 200kg significantly (P<0.05), increased tiller production in the two species throughout the planting season. There were 33.0% and 20.0% increases in 2004 when N-rates were increased from 100 to 150kg N/ha and 150 to 200N/ha respectively. During the 2005 planting season, the corresponding increases were 28.3% and 21.9%.

The two species produced their highest tillers from plots treated with 200kg Nha^{-1} and this was significantly higher than all other treatments. On the average, there was a 22 2% unit increase in the number of tillers produced for every increment of 50kg Nha. The general pattern of response and number of tillers produced by Ngg was significantly (P<0.05) higher than that of Gg when given the same treatment (Table 2).

Table 4: The effect of interval between harvests and species on the dry matter yield of green leaves (t/ha^{-1}) of two grass species (Mean of 4 levels) in 2004 and 2005 planting seasons.

Species	Harvesting intervals (weeks)				Species Mean
	4	6	8	10	
			2004		
Ngg	4 6	7 8	6 9	5 2	6 1
Gg	3 8	4 6	5 4	4 0	4.5
Mean	**4.2**	**6.2**	**6.2**	**4.6**	
			2005		
Ngg	4.4	7.6	6 5	5.1	5.9
Gg	4.0	4.4	5.3	4.2	4.5
Mean	**4.4**	**6.0**	**5.9**	**4.6**	

LSD (0 05) between treatment means

	2004	2005
Species	1.3	1 2
Harvest	1 4	1.3
Species x Harvest Interval	1.5	1 4

Table 5 The effect of species and Nitrogen on the Dry Matter yield of Green leaves ($t\ ha^{-1}$) of two Grass Species during the 2004 and 2005 planting seasons

Species	Mean of 4 harvesting intervals				Species Mean
	0	100	150	200	
			2004		
Ngg	3 6	4.3	8 4	6.8	6.2
Gg	3.1	3 7	6 9	6.8	5 3
Mean	**3.3**	**4.0**	**7.6**	**6.8**	
			2005		
Ngg	4.0	5.3	7.8	6.9	6 0
Gg	4 0	4.6	5.6	5.0	5 0
Mean	**4.0**	**4.9**	**6.9**	**5.8**	

LSD (0 05) between treatment means

	2004	2005
Species	0 6	0 5
Nitrogen	0 7	0.8
Species x Nitrogen	0 8	0.9

Table 6: The effect of species and harvesting intervals on the dry Matter Yield of Dead Leaves (t ha^{-1}) of two grass species during the 2004 and 2005 planting seasons

Species	Mean of 4 N-Leaves				Species Mean
	Harvesting intervals (weeks)				
	4	6	8	10	
			2004		
Ngg	0.12	0.28	0.63	0.75	0.44
Gg	0.13	0.39	0.84	0.96	0.56
Mean	**0.13**	**0.34**	**0.74**	**0.86**	
			2005		
Ngg	0.11	0.29	0.65	0.74	0.45
Gg	0.14	0.38	0.87	0.98	0.59
Mean	**0.13**	**0.34**	**0.76**	**0.86**	-

LSD (0.05) between treatment means

	2004	**2005**
Species	0.05	0.06
Nitrogen	0.08	0.07
Species x Nitrogen	0.12	0.12

Table 7: The effect of Species and Nitrogen on the Dry Matter Yield of dead leaves (t ha^{-1}) of two grass species, during the 2004 and 2005 planting seasons

Species	Mean of 4 harvesting intervals				Species Mean
	0	100	150	200	
			2004		
Ngg	0.16	0.20	0.39	0.44	0.30
Gg	0.26	0.33	0.70	0.74	0.51
Mean	**0.21**	**0.27**	**0.55**	**0.59**	-
			2005		
Ngg	0.24	0.34	0.58	0	
Gg	0.36	0.38	0.73	0.73	
Mean	**0.30**	**0.36**	**0.66**	**0.71**	-

LSD (0.05) between treatment means

	2004	**2005**
Species	0.05	0.06
Nitrogen	0.04	0.06
Species x Nitrogen	0.07	0.08

Table 8: Effect of Species and Nitrogen on Dry Matter Yield of 'stem' (t ha^{-1}) of two grass species during the 2004 and 2005 planting seasons.

Species	(Mean of 4 harvesting intervals weeks) Nitrogen Fertilizer Rates (KgNha^{-1})				Species Mean
	0	100	150	200	
			2004		
Ngg	0.34	0.47	0.56	0.87	0.56
Gg	0.30	0.34	0.43	0.76	0.41
Mean	**0.32**	**0.41**	**0.49**	**0.72**	-
			2005		
Ngg	0.36	0.45	0.56	0.88	0.56
Gg	0.23	0.46	0.52	0.65	0.47
Mean	**0.30**	**0.46**	**0.54**	**0.76**	-

LSD (0.05) between treatment means

	2004	2005
Species	0.04	0.05
Nitrogen	0.06	0.06
Species x Nitrogen	0.08	0.08

The mean interaction effect between harvest interval and N-fertilizer rates on number of tiller produced (Table 3) indicates that the highest number of tillers in both years (32 and 31) occurred in the plots cut every 8 weeks where 200kg Nha^{-1} was applied while the respective lowest values (8 and 7) occurred in the plots cut every 4 weeks where N was not applied. The harvest interval x Nitrogen interaction effect was significant in the 4,6 and 8 weekly cut plots only.

The number of tillers produced by the 10 weekly cut plots as influenced by N-fertilizer treatment was similar to that obtained in the 8-weekly cut plots throughout the experimental period. Thus, the N-fertilizer effect on enhancing tilering in the two species was limited by further extending the interval from 8-weekly cut to the 10-weekly cut during the planting season.

Table 4 shows that increasing the interval between harvests from 4 to 6 weeks and from 6 to 8 weeks, but not from 8 to 10 weeks, consistently increased the dry matter yield of green leaves in each of the species throughout the study period. The average effect showed that cutting any of the species every 6 or 8 weeks produced similar dry matter yield of green leaves, and the yield of the 4-weekly cut plots was similar to that of the 10-weekly cut plots throughout the study period. Thus, there were 34.7% drop in 2004, and 28.3% drop in 2005 when harvesting interval was increased from 8 to 10 weeks during the study periods The species x harvest interactions were significant ($P<0.05$) with the species producing their maximum dry matter yield at different harvesting intervals (Table 4) On the average, the dry matter yield of green leaves from Ngg was significantly ($P<0.05$) higher than the values obtained from Gg.

The effect of species and nitrogen on the dry matter yield of green leaves (t ha^{-1}) is presented on Table 5. Nitrogen application exerted a significant effect on the dry matter yield of green leaves on both species during the study period. Increasing nitrogen application from 100 to 150kg Nha^{-1} increased the dry matter yield of green leaves, with no further increase in plots that had 200kg Nha^{-1} Species differences to treatment was significant. The response of Ngg to N-fertilizer treatment in terms of dry matter yield of green leaves was significantly ($P<0.05$) higher than values obtained from Gg. The interaction of species x nitrogen was significant. The both species showed similar response to nitrogen fertilizer treatment, having their highest values of dry matter yield of green leaves from plots that had 150kg Nha^{-1} throughout the study period. The effect of species and harvesting interval on the dry matter yield of dead leaves (t ha^{-1}) of both species is presented on Table 6. The dry matter yield of dead leaves was increased by increasing the harvesting intervals from the 4-weekly cut to the 10-weekly cut throughout the experimental period The dry matter yields of dead leaves obtained by increasing harvesting intervals from 4 to 6, and from 6 to 8 were more than two-fold throughout the planting seasons. The dry matter yields of leaves obtained by Gg were significantly higher than values obtained from Ngg throughout the study period. The species x harvest interval interaction was significant. The response of both species to harvest treatment were similar and had their maximum dry matter yield at the 10-weekly cut plots. Delaying cutting in the both species significantly ($P<0.05$) increased the dry matter yield of dead leaves.

The effect of species and nitrogen on the dry matter yield of dead leaves (t/ha^{-1}) of both species is presented on Table 7 Increasing nitrogen application from 100 to 200kg Nha^{-1} consistently increased the dry matter yield of dead leaves of both species throughout the experimental period.

On the average there were 103.7% and 7.3% increases in the dry matter yield of dead leaves, when nitrogen fertilizer was increased from 100 to 150kg Nha^{-1} and from 150 to 200kg Nha^{-1} during the 2004 planting season. During the 2005 planting season, there were 83.3% and 7.6% increases in dry matter yield of green leaves when nitrogen fertilizer was increased from 100 to 150kg Nha^{-1} and from 150 to 200kg Nha^{-1} respectively. The response of Gg to this treatment was significantly ($P<0.05$) higher than that of Ngg throughout the study period. The species x nitrogen interaction was significant. Both species had their maximum dry matter yield of dead leaves from plots that had 200kg Nha^{-1}, and these values were higher than all other values.

The effect of species and nitrogen on the dry matter yield of "stem" (t ha^{-1}) of two grass species is presented on Table 8. "Stem" yield increases followed strictly, high level of nitrogen application in both species throughout the study period. Both species differed significantly in their response to nitrogen application. The values obtained by Ngg 0.56tha^{-1} each for 2004 and 2005 planting seasons, were significantly ($P<0.05$) higher than those of Gg throughout the planting season.

The interaction between nitrogen x species in terms of the dry matter yield of "stem" was significant. The species had their highest dry matter yield of stem from plots that had 200kg Nha^{-1} for both species, for every unit of 50kg Nha^{-1} added there was a significant increase in the dry matter yield of stem.

It should be noted that the initiation of flowers in Ngg was not forth coming up to the end of the experiment. Equally, flowers produced by Gg were scanty, and insufficient to warrant any statistical analysis. By the end of the last 10 weeks cycle, only very few flowers appeard in Gg.

DISCUSSION

Forage production is usually aimed at achieving high dry matter yield of good quality. An important factor that affects yield and quality has been the stage of maturity at which the plant is cut (Ubi and Ique, 2004).

The species differences in terms of dry matter yield of green leaves, recorded in this study as influenced by treatment combinations is attributable to the differences in the exposure time of their leaves based on the pattern of morphological development of individual species.

Evidently, Gg has slower rate of leaf turnover and rather fewer green leaves per tiller in Ngg, later in the season, appeared to reduce the expansion of the leaves for greater leaf surface for photosynthetic activities, thus causing sudden loss in green colour On the otherhand, delayed flowering in Ngg created an opportunity for extended exposure time of the leaf surface for photosynthetic activities, and has accounted for the high dry matter of green leaves obtained from this species and is in agreement with earlier works (Akinola et al, 1971, Pearse and Wilman, 1984; Wilman and Wright, 1994, Ubi and Omaliko, 2004)

The higher dry matter yield of "stem" at all treatment combinations reported for Ngg, especially at longer intervals of 8 and 10 weeks and higher N-rates is attributable to the efficient utilization of N-fertilizer by this species, with sufficient time space for photosynthetic tissue development and increase in the store reserve than Gg (Ubi and Ique, 2005).

The dry matter yield of dead leaves on a tiller at any given time depends on the differences between the rate of production and death of leaves. Again, the length of time a tiller survives has direct positive effect on the life span of a green leaf and the resulting dry matter yield of green and dead leaves of the tiller.

Floral initiation was delayed especially in Ngg until about a short period to the end of the last growing cycle. Thus, no satisfactory data was collected for an overall estimate of this parameter. A longer period of study is suggested as to give full floral development in both species.

The total number of tillers produced at a particular time is a measure of crop growth, which usually influences the amount of dry matter yield. In this, study, seasonal variations in the number of tillers produced was less pronounced in the frequency harvested plots, with a 16.0% increase in the number of tillers produced by harvesting the two species every 8 weeks. Similar results were also reported by Akinola et al (1971), Pearse and Wilman (1984), Ubi and Omaliko (2004). In the two species, a peak in tillering was reached at 8 weeks then dropped at 10 weeks, due to floral initiation and reduction in photosynthetic activities (Langer 1972, Wilman and Pearse 1984, Ubi and Omaliko, 2004). In this study, and as evidenced in others (Pearse and Wilman, Ubi and Ique, 2005) the number of tillers produced was increased by N-fertilizer application especially at high rates. Species differences in terms of number of tillers produced was clearly marked with Ngg producing more tillers than Gg and is attributable to the pattern of morphological development of individual species. In Gg, for instance, early floral initiation was observed with attendant reduction in photosynthetic activities in life tillers and a sudden drop in tiller production (Bean 1969; Langer 1972; Pearse, 1993) and that reduced photosynthetic activities due to self – shading effect may limit regrowth by way of production of new tillers (Ubi et al 2006).

CONCLUSION

The total number of tillers produced per hill in this study was highly influenced by the interval between harvest and N-fertilizer rates. The uniform trend in the number of tillers produced by the two species shows that much of nitrogen applied when plants were developing went into tiller growth and development. Thus, applying 200kg Nha^{-1} and harvesting at 8-weekly interval will give good management systems for the two species for greater economic benefit.

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