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Full Length Research Paper

Influence of cutting height and nitrogen fertilization on plant height and tiller production of guinea grass (*Panicum maximum* Jacq) pasture

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A study was conducted at Nsukka, Nigeria to determine the effects of cutting height and N fertilizer application on the growth and tiller production of *Panicum maximum* pasture. The experiment was a 3 × 3 factorial laid out in a randomized complete block design with three replications. Treatments comprised three cutting height (5, 10 and 15 cm) and three levels of nitrogen (0, 200 and 400 kg N ha^{-1}) resulting in nine treatment combinations per block. Plant height was significantly (P < 0.05) increased by 34 and 56% in 2008 and 2009, respectively, when cutting height increased from 5 to 15 cm. Grass tiller number per square metre varied inconsistently among the cutting heights at different harvest periods in both years. Grass height remained statistically similar among the nitrogen rates in both years but increased significantly (P < 0.05) with fertilizer N application compared with the control at some periods in both years. Grass tiller number obtained in 2008 from plots cut at 10 cm stubble height with 400 kg N ha^{-1} was significantly (P < 0.05) higher than those cut at 5 cm with zero N application. Cutting height × fertilizer-N interaction effect on plant height was significant (P < 0.05) in all the periods in both years.

Key words: Grass height, stubble height, tiller population, fertilizer N.

INTRODUCTION

Inadequate supply of feed in quantity and quality is responsible for the low productivity of animals in the tropics (Peters, 1988). The ruminant species in Nigeria depends entirely on natural pastures for their food (Abubakar and Ibrahim, 1998). This source is only adequate for their survival during the wet season but inadequate during the dry season. This has resulted in the characterized limitation posed by non availability of all-year-round feed resources due to prolonged dry season (Oladotun et al*.,* 2003; Odeyinka and Okunade, 2005).

There is the need to improve pasture production through properly planned management. Such management practices include cutting management and the use of fertilizers. Conflicting reports exist on the effect of cutting height on grass tiller density (Scheneiter et al., 2008). Several studies have found that under short cutting height regimes, grass tiller density increased and tiller weight/size decreased (Bircham and Hodgson, 1983; Lambert et al*.,* 1986; Davies, 1988). Carlassare and Karsten (2003) reported increase in grass tiller population with reduction in cutting height in orchad grass (*Dactylis glomerata*). A number of studies have found that when orchard grass, a tall-growing bunch-grass was grazed or cut frequently close to the ground level, its tiller density, stand persistence and productivity were limited by short grazing height regimes (Griffith and Teel, 1965; Fales et al*.,* 1995; Murphy et al*.,* 1997). Individual tiller size may change in a compensatory manner, usually described by the “self thinning” law, until plants reach their physiological potential under the applied management and environmental conditions (Yoda et al*.,* 1963; Sackville-Hamilton et al*.,* 1995; Matthew et al*.,* 1995). Barbosa et al. (1997), studying grass tillering under

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influence of nitrogen fertilization verified that the element showed a positive effect on the number of grass tillers. Report from Wilman and Asiegbu (1982), showed that nitrogen application increased plant height and grass tillers of grass in a perennial ryegrass-white clover-swards.

Some studies have been conducted on the effect of cutting frequency and nitrogen fertilizer application on plant height and tiller production in a degraded *P. maximum* pasture grown in Nsukka derived Savanna zone of Nigeria (Onyeonagu and Asiegbu, 2005). However, information is lacking on the combined effect of cutting height and nitrogen application on the growth and tiller production of *P. maximum* grown in Nigeria. This present investigation was designed to determine the effects of cutting height and nitrogen fertilizer application on plant height and tiller production of *P. maximum* grown in Nsukka, Nigeria.

MATERIAL AND METHODS

Experiment site

The experiment was conducted on a guinea grass (*P. maximum*) pasture established in 2000 at the Teaching and Research Farm of the Department of Crop Science Faculty of Agriculture University of Nigeria, Nsukka. Nsukka is located at Latitude 06° 52`N and longitude 07° 24`E, and altitude of 447.2 m above sea level. This place is characterized by the low land humid tropical conditions. The soil is classified as an Ultisol (Asiegbu, 1989). The experiment was a 3 × 3 factorial laid out in a randomized complete block design and was done in triplicate. Treatments comprised three cutting heights of 5, 10 and 15 cm and three levels of nitrogen at 0, 20 and 400 kg N ha^{-1}. There were nine treatment combinations as follows:
A portion of the pasture land with an area of 143.4 m^2 was marked out into three blocks of 10.8 × 2.4 m each with a sampling area of 1 × 1 m. Each block was separated by one meter path-way. Each plot measured 2.4 × 1.2 m. The treatment combinations were allocated completely at random in each of the three blocks.

Data collection

Plant height was taken using the mean of three readings taken at random from the sample area in each plot. Tiller counts were made in each plot using a 25 cm square quadrant. The mean of three throws per plot was used to calculate tiller population per m^2.

Statistical analysis

All data collected were statistically analyzed according to the procedure outlined by Steel and Torrie (1980), for factorial experiment in a randomized complete block design using GENSTAT (2009) statistical package. Separation of treatment means for statistical significance was done using the least significant difference (LSD).

RESULTS

Grass height increased ($P < 0.05$) progressively with increase in cutting height in 2008 and 2009 (Table 1). Plant height did not attain any significant difference among the different fertilizer N rates in both years. In 2008, cutting at 5 cm height with 200 kg N ha^{-1} gave the lowest ($P < 0.05$) plant height while harvesting at the 15 cm height with the same level of N application gave the highest ($P < 0.05$) plant height. There was no significant cutting height × nitrogen interaction effect in 2009.

Plant height increased significantly ($P < 0.05$) with fertilizer N application compared with the control during the first harvest period in 2008, but was similar for the 200 and 400 kg N ha^{-1} (Table 2). Grass height increased ($P < 0.05$) progressively with increase in height of cut. The highest ($P < 0.05$) plant height was obtained at the 15 cm cutting when 400 kg N ha^{-1} was applied. There was no significant increase in plant height with fertilizer application at the second harvest period. Increasing the height of cut from 5 cm to 15 cm resulted in a progressive increase ($P < 0.05$) in plant height. Cutting at 5 cm height with the application of 200 kg N ha^{-1} gave the least ($P < 0.05$) plant height during the second harvest period, whereas the 15 cm cutting with the same amount of fertilizer N application gave the highest plant height during the same harvest period. Plant height obtained during the third period followed the same trend to the situation in the second harvest period with respect to cutting height and fertilizer N application. Cutting at 5 cm with the application 200 kg N ha^{-1}, gave significantly ($P < 0.05$) the least plant height during the third harvest period while the highest plant height was obtained on the application of 0 kg N ha^{-1} at 15 cm height of cut. Grass height seemed to increase with increase in season but decreased at the late season.

In 2009, grass height significantly increased ($P < 0.05$) with increase in height of cut in all the harvest periods (Table 3). Fertilizer-N application showed no significant effect on grass height during the first three and last periods. At the fourth harvest period, the 200 kg N ha^{-1} produced plants that were taller ($P < 0.05$) than those from the control treatment but were similar with those from the 400 kg N ha^{-1}. Height of cut × fertilizer-N interaction effect was not significant in most of the harvest periods except at the fourth period where harvesting at the 15 cm height with zero N application produced plants that were taller ($P < 0.05$) than those from the other cutting heights at any N rate.

Grass tiller number per square metre was not significantly affected by fertilizer N application or cutting management in 2008 (Table 4). The highest tiller number was obtained when cutting was done at 10 cm height with 400 kg N ha^{-1}. Fertilizer N application, cutting height and their interaction showed no significant effects on grass tiller number in 2009.

There was a significant ($P < 0.05$) increase in the number of tillers per square metre with fertilizer application compared with the control during the first harvest period in 2008 (Table 5). Grass tiller number remained

Table 1. Effect of cutting height and fertilizer-N application on the grass height (cm).

Cutting height (cm)	Nitrogen fertilizer (kg N ha^{-1})			
	0	200	400	Mean
		Year 2008		
5	65.6	61.6	64.6	63.9
10	68.3	78.7	78.8	75.3
15	82.1	89.5	85.2	85.6
Mean	72.0	76.6	76.2	74.9
		Year 2009		
5	35.4	43.1	45.3	41.3
10	54.0	53.0	52.5	53.2
15	66.3	65.6	62.0	64.6
Mean	51.9	53.9	53.3	53.0
	2008		**2009**	
$LSD_{0.05}$ for comparing 2 nitrogen means (N)	-		-	
$LSD_{0.05}$ for comparing 2 height means (H)	4.93		4.16	
$LSD_{0.05}$ for comparing 2 N x H means	8.54		-	

-, Non-significant F-test at 5% probability level.

Table 2. Effect of cutting height and fertilizer-N application on the grass height (cm) at different periods of the year 2008.

Cutting height (cm)	Nitrogen fertilizer (kg N ha^{-1})			
	0	200	400	Mean
October 7 to 28				
5	37.9	50.4	51.9	46.7
10	42.9	55.8	55.5	51.4
15	47.5	58.7	61.8	56.0
Mean	42.8	55.0	56.4	51.4
October 28 to November 18				
5	86.7	85.3	88.8	86.9
10	94.3	97.5	99.6	97.1
15	101.0	113.1	107.6	107.2
Mean	94.0	98.6	98.7	97.1
November 18 to December 9				
5	63.2	49.1	53.1	55.1
10	67.8	82.8	81.2	77.2
15	97.7	96.7	86.3	93.6
Mean	76.2	76.2	73.5	75.3
	1st Period	**2nd Period**		**3rd Period**
$LSD_{0.05}$ for comparing 2 nitrogen means (N)	4.34	-		-
$LSD_{0.05}$ for comparing 2 height means (H)	4.34	9.03		10.13
$LSD_{0.05}$ for comparing 2 N x H means	7.51	15.65		17.54

-, Non-significant F-test at 5% probability level.

similar for the 200 and 400 kg N ha^{-1}. The highest ($P < 0.05$) number of tillers was obtained when grass was cut at 15 cm height while the least tiller number was obtained at 5 cm cutting during the first harvest period. Grass tiller number was similar for the 10 and 15 cm heights of cut. The lowest number of tillers was obtained at the application of 0 Kg N ha^{-1} with 5 cm stubble height. The highest number of tillers was achieved at 400 kg N ha^{-1} when cutting was done at 15 cm during the same period. Fertilizer N application, cutting height and their interaction

Table 3. Effect of cutting height and fertilizer-N application on the grass height (cm) at different periods of the year 2009.

Cutting height (cm)	Nitrogen fertilizer (kg N ha^{-1})			
	0	200	400	Mean
May 2 to 23				
5	49.33	56.78	61.89	56.00
10	82.11	68.89	75.33	75.44
15	105.56	94.78	75.67	92.00
Mean	79.00	73.48	70.96	74.48
May 23 to June 13				
5	36.78	49.72	46.94	44.48
10	64.00	52.61	57.28	57.96
15	82.50	73.72	67.55	74.59
Mean	61.09	58.69	57.26	59.01
June 13 to July 4				
5	35.05	41.11	46.72	40.96
10	47.94	50.11	46.56	48.20
15	61.17	63.78	62.56	62.50
Mean	48.05	51.67	51.95	50.56
July 4 to July 25				
5	31.89	37.00	37.33	35.41
10	42.39	51.61	43.78	45.93
15	50.67	55.72	57.50	54.63
Mean	41.65	48.11	46.20	45.32
July 25 to August 15				
5	28.39	40.22	35.94	34.85
10	35.17	45.39	46.72	42.43
15	45.05	49.39	56.28	50.24
Mean	36.20	45.00	46.31	42.51
August 15 to September 5				
5	31.11	34.05	43.67	36.28
10	52.61	49.67	45.56	49.28
15	52.83	56.33	52.55	53.91
Mean	45.52	46.69	47.26	46.49

	1st Period	2nd Period	3rd Period	4th Period	5th Period	6th Period
LSD $_{0.05}$ for comparing 2 nitrogen means (N)	-	-	-	4.998	4.557	-
LSD $_{0.05}$ for comparing 2 height means (H)	10.593	8.585	7.503	4.998	4.557	9.253
LSD $_{0.05}$ for comparing 2 N x H means	18.348	-	-	-	-	-

(–): Non-significant F-test at 5 % probability level.

effects did not have any significant effect on tiller number per square metre at the second and last periods of the year. Grass tiller number seemed to decrease with season and then increase later.

Fertilizer N application and cutting height × fertilizer interaction showed no significant effects on grass tiller number in any of the harvest periods in 2009 (Table 6). Grass tiller number was not significantly affected by cutting height at the first, third, and fifth harvest periods. Tiller number was similar for the 5 and 10 cm at the second period but was lower ($P < 0.05$) when cutting was done at 15 cm height compared with the 5 cm. During the fourth period, the 5 cm cutting produced lower ($P < 0.05$) number of tillers than the other cutting heights which were similar.

The 15 cm cutting yielded greater ($P < 0.05$) number of tillers during the last harvest period than the 5 cm but was similar with the 10 cm.

DISCUSSION

This study was conducted to assess the performance of *P. maximum* pasture under different cutting heights and

Table 4. Effect of cutting height and fertilizer-N application on the grass tiller number per square metre.

Cutting height (cm)	Nitrogen fertilizer (kg N ha^{-1})			
	0	**200**	**400**	**Mean**
		Year 2008		
5	1365.9	1611.3	1523.0	1500.0
10	1552.0	1517.6	1669.3	1579.6
15	1470.2	1601.8	1637.3	1569.8
Mean	1462.7	1576.9	1609.9	1549.8
		Year 2009		
5	1886.5	1818.1	1792.1	1832.3
10	1870.5	1926.4	1932.2	1909.7
15	1904.6	2004.2	1946.4	1951.7
Mean	1887.2	1916.2	1890.2	1897.9
		2008		**2009**
LSD $_{0.05}$ for comparing 2 nitrogen means (N)		-		-
LSD $_{0.05}$ for comparing 2 height means (H)		-		-
LSD $_{0.05}$ for comparing 2 N x H means		275.36		-

(–): Non-significant F-test at 5 % probability level

Table 5. Effect of cutting height and fertilizer-N application on the grass tiller number per square metre at different periods of the year 2008.

Cutting height (cm)	Nitrogen fertilizer (kg N ha^{-1})			
	0	**200**	**400**	**Mean**
October 7 to 28				
5	819.6	1072.0	858.7	916.7
10	997.3	1100.3	1312.0	1136.6
15	1048.9	1084.4	1473.8	1202.4
Mean	955.3	1085.6	1214.8	1085.2
October 28 to November 18				
5	1568.0	1923.6	1658.7	1716.7
10	1630.2	1578.7	1555.6	1588.1
15	1530.7	1806.2	1742.2	1693.0
Mean	1576.3	1769.5	1652.1	1666.0
November 18 to December 9				
5	1710.2	1838.2	2051.6	1866.7
10	2028.4	1873.8	2140.4	2014.2
15	1831.1	1914.7	1696.0	1813.9
Mean	1856.6	1875.6	1962.7	1898.3
	1st Period	**2nd Period**		**3rd Period**
LSD $_{0.05}$ for comparing 2 nitrogen means (N)	225.65	-		-
LSD $_{0.05}$ for comparing 2 height means (H)	225.65	-		-
LSD $_{0.05}$ for comparing 2 N x H means	390.83	-		-

(–): Non-significant F-test at 5 % probability level.

nitrogen fertilizer rates. In this study, plant height increased progressively with increase in cutting height. Similar result was reported by Da Silveira et al. (2010) with *P. maximum*. Close cutting of grasslands above ground level was shown to reduce the ability of the grasses to replenish leaf area and set seeds, interfere with the growing points, weaken the rooting systems and reduce stored food reserves in their roots, thereby reducing grass growth (Adams et al., 1991; Orodho, 2006).

The lower plant height observed in this study with

Table 6. Effect of cutting height and fertilizer-N application on the grass tiller number per square metre at different periods of the year 2009.

Cutting height (cm)	Nitrogen fertilizer (kg N ha^{-1})			
	0	200	400	Mean
May 2 to 23				
5	1818.7	2062.2	2037.4	1972.7
10	1914.7	2024.9	2010.7	1983.4
15	1736.9	2277.3	1816.9	1943.7
Mean	1823.4	2121.5	1955.0	1966.6
May 23 to June 13				
5	2469.3	2423.1	2256.0	2382.8
10	2000.0	2250.2	2275.6	2175.3
15	1900.4	2156.4	1985.8	2014.2
Mean	2123.3	2276.6	2172.5	2190.8
June 13 to July 4				
5	1975.1	1733.3	1847.1	1851.9
10	2078.2	1996.4	1852.4	1975.7
15	2000.0	2181.3	2046.2	2075.8
Mean	2017.8	1970.4	1915.2	1967.8
July 4 to 25				
5	1900.4	1822.2	1799.1	1840.6
10	2055.1	2158.2	2286.2	2166.5
15	2414.2	1996.5	2197.3	2202.7
Mean	2123.3	1992.3	2202.7	2069.9
July 25 to August 15				
5	1882.7	1715.6	1896.0	1831.4
10	1815.1	1818.7	1813.3	1815.7
15	1742.2	2023.1	1964.4	1909.9
Mean	1813.3	1852.4	1891.2	1852.3
August 15 to September 5				
5	1272.9	1152.0	917.3	1114.1
10	1360.0	1310.2	1354.7	1341.7
15	1633.8	1390.2	1667.6	1563.9
Mean	1422.2	1284.2	1313.2	1339.9

	1st Period	2nd Period	3rd Period	4th Period	5th Period	6th Period
$LSD_{0.05}$ for comparing 2 nitrogen means (N)	-	-	-	-	-	-
$LSD_{0.05}$ for comparing 2 height means (H)	-	244.86	-	289.55	-	229.13
$LSD_{0.05}$ for comparing 2 N x H means	-	-	-	-	-	-

(–), Non-significant F-test at 5 % probability level.

reduced nitrogen rates, is the result of more dependence of grass plants for nitrogen on soil resources as reported by Tariq et al. (2011). Wilman and Asiegbu (1982) working with perennial ryegrass (*Lolium perenne*), showed that increasing higher plant height with nitrogen application could be attributed to the increase in leaf area with increase in nitrogen application.

Grass tiller number per square meter was not significantly influenced by height of cutting as was reported by Wijitphan et al. (2009). These authors showed that number of tillers and mean tiller weight of grass were not significantly affected by cutting height and indicated that this behavior could be explained using the size-density compensation index, the least size tillers is compensated by high tiller population density (Hernandez et al., 1999). Chapman and Lamaire (1993) reported that under severe defoliation condition, morphological adjustments are needed to ensure homeostatic whole plant growth. The inconsistency in the number of tillers m^{-2} observed with cutting treatment at different harvest periods in both years was confirmed by Scheneiter et al. (2008). Tillering in grasses is a very dynamic process, and time of sampling can strongly influence the situation encountered (Gutman et al., 2001; Scheneiter et al., 2008).

This present study revealed increase (P > 0.05) in grass tiller number with nitrogen application. Tiller number per square meter increased by 10% when fertilizer-N was increased from 0 to 400 kg N ha^{-1}. Barbosa et al. (1997) obtained a similar result with guinea grass (*P. maximum*). They reported that nitrogen application significantly increased grass tiller number. Wilman and Asiegbu (1982) also observed that fertilizer-N application increased grass tiller number in perennial ryegrass from 492 tillers per 0.1 m^2 with zero N to 675 tillers per 0.1 m^2 with 224 kg N ha^{-1}.

Conclusion

The highest tiller number was at 10 cm when compared with the 15 cm cutting height and was low at 5 cm cutting height. The tiller number and plant height were generally increased with incremental application of fertilizer-N. The highest plant height was achieved when 15 cm cutting height was combined with the application of 200 kg N ha^{-1}.

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