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INFLUENCE OF CUTTING FREQUENCIES AND N-RATE ON PERCENT WATER CONTENT OF HERBAGE IN THREE GRASS SPECIES

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ABSTRACT

An experiment conducted on 5th April 2002 at Iwaru 35km from Calabar, Nigeria, to estimate the influence of six cutting frequencies (2,3,4,5,6 and 8) and four N-rates (0.100,200 and 300kg N/ha) on percent water content of Northern gamba grass, (*Andropogon gayanus*) symbolized-Ngg, Guinea grass CV S112 (*Panicum maximum*) – Gg and Star grass (*Cynodon polystarchyus*) – Sg. The result showed that cutting frequencies and N-rates exerted significant ($P < 0.05$) effect on the percent water content of leaf blades, leaf sheaths and 'stem'. Doubling the cutting frequencies from 2 to 4, weeks, significantly increased the percent water content of leaf blades, leaf sheaths and 'stem'. Highest percent water content of leaf blades, leaf sheaths and 'stem', on the average were obtained from plots cut every 5 weeks where 300Kg N/h was applied while the least was obtained from the 8-weekly cut plots, at 0kg N/ha. There was an increase in percent water content of leaf blades, leaf sheaths and stem for every addition of 100Kg N/ha. Species differences in terms of percent water content as influenced by treatment was significant ($p<0.5$), with the species producing their highest percent water content at different harvesting intervals. Ngg had the highest percent water content in all the parameters observed, and the values were significantly ($P<0.05$) higher than those of either Gg or Sg. These results showed that potential water content was reduced by cutting frequencies of 6 and 8 weeks, later in the season. The percent water content of 'stem' on the average was significantly ($P<0.05$) higher than all other values obtained from either leaf blades; or leaf sheaths. The implications of these findings are discussed in light of management of field sward throughout the growing season.

KEYWORD: Cutting Frequencies, N-rates, Water content, Herbage, Grass species.

INTRODUCTION

Interest in grassland research with a view to providing all season feed for the livestock industry has continued to be sustained over several decades. Grasses such as *Panicum maximum* (Guinea grass Cv. S. 112) *Andropogon gayanus* (northern gamba grass and *Cynodon polystachyus* (star grass) are adapted to a wide range of soils in the Savannah zone of the tropics. Frequency of cuts and nitrogen application are two major factors affecting the productivity of field swards. One of the things that could affect the feeding value of herbage is the state of maturity at which the crop is cut (Ubi and Omaliko 2004).

The first requirement of top quality grass are that it should be palatable, highly digestible and of such composition that the product of digestion are used with maximum efficiency with no toxic materials.

Water content of herbage plays a key role in enhancing palatability and digestibility (Wilman et al 1998). Equally, stage of maturity at which the crop is harvested and the levels of nitrogen fertilizer application had been reported to have significant effect on the water content of herbage. (Oyenuga 1960; Haggar 1970; Wilman et. al. 1998). Nitrogen applied to pure grass sward has been found to have some effect on digestibility due to a fall in water-soluble carbohydrate, which follow nitrogenous manuring (Adesogan et al 1998). Dent and Aldrich (1968) reported that palatability is positively related to water-soluble carbohydrate content. Certain weather conditions such as high temperatures, humidity and an environmental condition such as water stress could affect the nutrient up take and water content of plant components (Wilman *et al* 1999; Hussan and Leitch 2000). The objective of this study is to estimate the state of cut and N-rate that will give optimum water content in herbage using treatment combinations.

MATERIALS AND METHODS

Two experiment were conducted in April 5th, 2002 from swards established in March 10th, 2001 at Iwuru near Calabar (longitude 8°14' and 8°20'E and latitude 5°14'N and 5°18'N; rainfall surplus over 2,000mm in the rainforest vegetation of the basement complex soil). The area was previously cropped with cassava followed by four years fallow in which *Centrosema pubsecence* and guinea grass (*Panicum maximum*) were the dominant fallow species. The site was manually cleared, allowed to dry for some days then gathered together and removed. The trial was on 3 x 4 x6 split-split plot in a randomized complete block (RCB) design replicated three times. Plot size was 3m x 48m and sampling area was 2m x 2m. Six harvesting intervals were adopted namely: 2, 3, 4, 5 and 8 weeks. Four different levels of nitrogen fertilizer in form of urea were (0,100,200, and 300KgN/ha). In addition, single applications in each year of phosphorus and potash fertilizers were made to all plots after clearing cut at the beginnings of each growing season, at the rate of 122.2p/ha and 375 K/ha, respectively. The three grass species used were: Northern gamba grass (*Andropogon gayanus*) Ngg, Guinea grass (*Panicum maximum* CV. S112)- Gg and Star grass, (*Cynodon polystarchyus*) Sg.

Harvesting was done manually following the harvesting Calendar leaving a stubble, 15cm high. At each cut, 500g fresh weight sample was taken from each sampling area and separated into leaf blades, leaf sheath and 'stem' and weighed immediately after harvest. Separated samples were wrapped in newsprints then dried for 72 hrs at 65°C using moisture extraction ovum. Samples were weighed for dry weight determination and the percent water content of each plant components was calculated.

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Statistical Analysis

Crop data were subjected to analysis of variance (ANOVA) and means compared with the Fisher's Least Significant Difference (LSD) at 5% probability level.

RESULTS

The rainfall data collected about 35km from the experimental site are shown in Table 1. From the data, rainfall and temperature figures for the months of March and April were sufficiently high to support crop growth.

Table 1: Average rainfall values from 2000 to 2002

Months	Average of 2000/2001 (mm)	Average of 2000/2001 (mm)	Average Temperature (°C) (2000-2002) (mm)
January	3.8	4.1	32.0
February	7.8	8.9	33.2
March	64.1	63.0	35.6
April	56.3	34.7	37.5
May	87.6	90.8	34.1
June	113.7	108.5	34.0
July	89.2	86.3	31.6
August	71.8	76.3	32.8
September	76.4	81.1	31.0
October	38.7	40.4	31.2
November	32.6	36.0	29.8
December	30.9	32.1	27.0
Mean	62.4	55.9	32.3

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

The results of harvesting interval x species; harvesting intervals x nitrogen and nitrogen x species on percentage water content of leaf blades of three grass species are presented in Tables 2a, b and c.

The mean moisture water content was highest (80.1%) when the sward was cut every 5 weeks and least (60.3%) when cut every 8 weeks. Doubling the intervals from 2 to 4 weeks significantly ($P < 0.05$) increased the % water content of leaf blades. The species differed significantly in their response to harvesting intervals and N-application with Ngg recording the highest value of 73.6% which was significantly ($P < 0.05$) greater than those of either Gg (72.2%) or Sg (63.4%).

The interaction of harvest x nitrogen in terms of % water content of leaf blade was significant ($P<0.05$). Cutting every 5 weeks where 300kg N/ha was applied had the highest % water content of leaf blades (81.5%) and this value was significantly higher than those of other treatments. The lowest % water content (60.0%) occurred in 2-weekly cut plots where no fertilizer was applied.

Table 2a: Effect of Harvesting Intervals on Percent Water content of leaf blades

Species	Harvesting Intervals (Weeks) 2	3	4	5	6	8	Species Mean
Ngg	74.1	75.6	77.2	80.1	72.4	62.5	73.6
Gg	73.4	74.8	76.5	78.4	70.0	60.3	72.2
Sg	61.3	74.8	68.3	70.3	65.2	54.1	63.4
Mean	69.6	71.5	74.5	74.5	76.2	69.2	58.9

LSD (0.05) between 2 treatment means
LSD (0.05) between 2 Harvesting intervals means 1.2
LSD (0.05) between 2 Species means 1.3
LSD (0.05) between 2 Harvesting intervals x Species means 1.6

Table 2b: Effect of Harvesting Intervals x Nitrogen Rates on Percent Water content of Leaf Blades

N-rates (Kg N/ha^{-1})	(Harvesting Intervals (Weeks)) 2	3	4	5	6	8	Nitrogen Mean
0	60.0	63.4	64.0	66.2	62.1	60.4	63.0
100	66.2	70.3	72.1	74.2	67.4	63.3	68.0
200	69.4	74.4	76.0	79.4	68.1	65.7	72.1
300	71.5	76.1	78.3	81.5	70.3	68.5	74.3
Mean	65.2	71.0	72.6	75.3	66.9	64.4	

LSD (0.05) between 2 treatment means
LSD (0.05) between Harvesting interval means 1.4
LSD (0.05) between 2 Nitrogen means 2.8
LSD (0.05) between 2 Harvesting intervals x Nitrogen means 3.1

Table 2c: The Interaction between Species x Nitrogen on Percent water content of leaf blade

Species	N-rates (KgN/ha) 0	100	200	300	Species mean
Ngg	68.3	76.1	78.4	86.6	77.4
Gg	64.7	74.3	76.7	82.0	74.4
Sg	62.2	70.5	72.5	75.3	70.1
Mean	65.1	73.6	75.8	81.3	

LSD (0.05) between 2 treatment means
LSD (0.05) between 2 Harvesting intervals means 2.1
LSD (0.05) between 2 Species means 2.5
LSD (0.05) between 2 Harvesting intervals x Species means 2.8

The interaction of nitrogen x species in terms of % water content of leaf blades was significant. Increasing N application significantly increased the % water content of leaf blades. Increasing N-fertilizer application from 100 Kg N/ha to 200Kg N/ha correspondingly increased the % water content by 2.9%. The response of three species to six different harvesting intervals and N application on % water content of leaf sheath is presented in Tables 3a, b and c.

Table 3a: Effect of Harvesting Intervals on percent water content of leaf sheath

Species	Harvesting Intervals (Weeks) 2	3	4	5	6	8	Species Mean
Ngg	78.1	80.0	82.0	85.1	74.3	71.0	78.4
Gg	76.4	78.4	80.2	82.0	71.6	68.9	76.2
Sg	68.2	69.0	71.0	78.6	66.1	64.0	69.4
Mean	74.2	75.8	77.7	81.9	70.6	67.9	

LSD (0.05) between 2 treatment means
LSD (0.05) between 2 Harvesting intervals means 1.2
LSD (0.05) between 2 Species 2.1
LSD (0.05) between 2 Harvesting intervals x species means 2.6

The interaction of harvesting interval and species in terms of % water content of leaf sheath was significant ($P<0.05$). The mean % water content was highest (85.1%) when sward was cut every 5 weeks and lowest (64.0%) when cut every 8

Table 3b: Effect of Harvesting Intervals x Nitrogen Rates on % Water Content of Leaf Sheath.

N-rates (Kg N/ha^{-1})	Harvesting Intervals (Weeks) 2	3	4	5	6	8	Nitrogen Mean
0	62.5	64.6	70.2	71.2	66.1	62.6	66.2
100	73.6	75.1	77.8	79.6	68.3	64.1	73.1
200	74.4	76.9	79.7	82.3	74.0	71.2	76.4
300	76.7	78.6	80.4	85.4	76.6	73.4	78.5
Mean	71.8	73.8	77.0	79.6	71.2	67.8	

LSD (0.05) between 2 treatment Means
LSD (0.05) between 2 Harvesting intervals Means 2.0
LSD (0.05) between 2 Species 2.5
LSD (0.05) between 2 Harvesting intervals x Species Means 3.1

Table 3c: Species x Nitrogen Interaction on % water Content of leaf sheath

Species	N-rates (KgN/ha) 0	100	200	300	Species mean
Ngg	76.1	81.2	81.7	83.6	80.7
Gg	74.7	76.3	79.4	81.2	77.9
Sg.	71.0	74.1	76.5	78.5	74.9
Mean	73.9	77.2	79.2	81.0	

LSD (0.05) between 2 treatment means
LSD (0.05) between 2 Harvesting intervals means 2.3
LSD (0.05) between 2 Species means 2.8
LSD (0.05) between 2 Harvesting intervals x Species means 3.2

weeks. Doubling the intervals between harvest from 2 to 4 weeks significantly increased % water content of leaf sheath in the three species. The % water content increased from 2 weeks cuts to 5 weeks cuts and then dropped from 6 weeks cuts to 8 weeks cut. There were significant ($P < 0.05$) differences between the three species in terms of leaf sheath with Ngg on the average, having the highest (78.4%) and this was significantly higher than those of either Gg (76.2%) or Sg. (69.2%) during the study period. Again cutting any of the species every 5 weeks gave the highest water content in the leaf sheath.

The interaction of harvesting interval x nitrogen in terms of % water content of leaf sheath was significant ($P < 0.05$). Highest % water content (85.4%) occurred in 5-weekly cut plots where 300Kg N/ha was applied while the least 62.6% occurred in plots cut every 8 weeks where No N was applied. Equally important is the fact that the % water content observed in the 2-weekly cut plots (71.8%), was higher than that obtained from the 6 weekly cut plots (71.2%)

The Nitrogen x species interaction showed a significant ($P < 0.05$) effect on the % water content of leaf sheath. Highest % water content (83.6%) occurred in plots that received 300 Kg N/ha while the least on the average, (71.0%) occurred in plots where no N was applied. There was a 2.5% unit increase in % water content when N-rate was increased from 100Kg N/ha to 200Kg N/ha and a further 2.2% unit increased when N was increased from 200Kg N/ha to 300Kg N/ha. Thus, for the three species for every unit of 100Kg N added there was a corresponding increase in the % water content of leaf sheath.
The effect of cutting frequencies and nitrogen fertilizer application on % water content of 'stem' of three species of grasses is presented in Table 4a, b and c. the response of the

Table 4a: Effect of Harvesting intervals on percent water contents of stem

Species	Harvesting Intervals (Weeks) 2	3	4	5	6	8	Nitrogen Mean
Ngg	77.4	81.1	83.3	88.5	78.4	74.6	80.5
Gg	74.1	79.3	81.5	86.2	76.1	72.7	78.3
Sg	72.1	72.6	75.8	77.0	73.1	70.4	73.5
Mean	74.2	77.6	80.2	83.9	75.8	72.5	

LSD (0.05) between 2 treatment means
LSD (0.05) between 2 Harvesting means 1.2
LSD (0.05) between 2 Species means 2.1
LSD (0.05) between 2 Harvesting intervals x Species means 2.4

Table 4b: Interaction between Harvesting interval x Nitrogen on Percent water content of stem

N-rates (Kg N/ha)	Harvesting Intervals (Weeks) 2	3	4	5	6	8	Nitrogen Mean
0	55.2	58.4	59.5	63.2	61.5	54.1	58.6
100	68.6	71.1	75.6	79.0	72.0	63.4	71.6
200	69.8	72.8	78.7	82.4	74.6	68.0	74.3
300	72.1	70.2	73.7	77.7	71.1	64.1	71.4
Mean	64.3	70.2	73.7	77.7	71.1	64.1	

LSD (0.05) between 2 treatment means
LSD (0.05) between 2 Harvesting means 1.3
LSD (0.05) between 2 Nitrogen means 2.2
LSD (0.05) between 2 Harvesting intervals x Nitrogen means 2.5

Table 4c: Interaction between Species x nitrogen on Percent water content of stem

Species	N-rates (KgN/ha) 0	100	200	300	Species mean
Ngg	73.0	76.2	83.1	86.5	79.7
Gg	71.5	73.8	81.0	83.6	77.4
Sg	68.9	72.0	80.1	81.5	75.6
Mean	71.1	74.0	81.7	83.8	

LSD (0.05) between 2 treatment means
LSD (0.05) between 2 Nitrogen means 1.4
LSD (0.05) between 2 Species means 1.6
LSD (0.05) between 2 Nitrogen x Species means 2.0

three species to harvest x species and harvest x nitrogen in respect of % water content of 'stem' was significant ($P < 0.05$) . Highest % water content of 'stem', (88.5 %) on the average, was obtained from plots cut every 5 weeks while the least (70.4%) was obtained from plots cut every 8 weeks. Species differences in terms of % water content of stem was significant ($P < 0.05$), with Ngg having, on the average, the highest % water content of 'stem' (80.5%) and this was significantly higher than those of either Gg (78.3%) or Sg (73.5%). The three species produced their highest % water content in the 5 – weekly cut plots.

The harvest x nitrogen interaction showed that highest % water content of stem, (86.5%) on the average, was obtained from the 5-weekly cut plots that received 300Kg N/ha treatment and this was significantly higher than those of all other treatments. The average % water content of 'stem' obtained from the 2-weekly cut plots (66.3%) was significantly higher than that obtained from the 8-weekly cut plots.

The effect of N-application on the % water content of 'stem' in the three species, was significant ($P < 0.05$). There was a 10.4% unit increase in % water content of 'stem' on the average when N-rates was increased from 200Kg N/ha to 300Kg N/ha in the three species throughout the experimental period.

DISCUSSION

The response of the grass species to various combinations of harvesting interval; nitrogen application and species have been characterized by a positive interaction of the three factors of which harvesting frequencies and N-rates exerted significant influence on % water content of the crop. In working with guinea grass (*Panicum maximum*, *CV S112*), Oyenuga, (1960) reported water content of leafy – mature herbage to be between 72 – 66%; and in a similar experiment, Haggar (1970) found the % water content of leafy mature northern gamba grass (*Andropogon gayanus*) to be between 72 – 62%. In this study, the % water content of leafy mature blades was between 80.1 to 60.1% as influenced by frequencies of cuts, on the average, and between 86.6 – 62.2% as influenced by nitrogen application.

The high % water content reported in this study is suggested to be due to heavy nitrogen fertilization and high precipitation in the area. Hardness (1966) in working with Italian rye grass (*Lolium multiflorum*) reported that increase in nitrogen fertilization from 44 Kg N/ha to 300Kg N/ha increased the water content from 78.0 to 85.0%, and is in agreement with the report in this study.

The physiological process involving cell expansion and cell division as a result of high rates of N-application is suggested to be responsible for the high percent water content reported in this study, Moghaddam and Wilman (1998).

The point of interest observed in the study was that leaf sheath and stem, tended to have more water content than the leaf blades, at least until when the 'stem' matured, and dried out. The differences are suggested to be due to high rates of water utilization during photosynthesis in the leaves while the transport role of stem and sheath accounts for the large quantity of water in these organs, Wilman and Fisher (1996).

The level of water in herbage could be dependent not only on the state of growth but also on the overall climate conditions and the level of water supply at the root surface to the plant tissues. Deinum (1966) reported that Increasing temperature with low light intensity and humility control, lowers the water content of rye grass; and Wilson and Ford (1971) found that the effect can be more marked and variable in tropical grasses.

Evidently, Ngg has slower rate of leaf turn over, than either Gg or Sg and rather fewer leaves per tiller; nevertheless because of the larger, succulent leaves, Ngg has the greates % water content in leaf blade, leaf sheath and 'stem' than either Gg or Sg. The water requirement and even their content in given species may vary considerably under the same climatic conditions as it was evidenced in this study. From our findings, it will be more profitable to adapt management system in which herbage is cut every 5 weeks for the three species with the application of 300Kg N/ha that will give good palatability with higher digestibility, and greater economic returns to the livestock farmer.

CONCLUSION

Herbage of high water content is likely to be softer and broken down more likely by chewing to give ruminant digesta of low dry matter than herbage of low water content (Mtengeti et al 1996; Wilman et al. 1996). This could mean a different digestion rate for the herbage of high water content. It is therefore suggested that cutting frequency of 5- weekly cuts with the N-rate of 300Kg N/ha could be a good management option in field swards and livestock industry for more economic benefits.

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