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Research Article

Effect of Age at Harvest and Varieties on the Growth and Yield of *Cenchrus purpureus*

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Abstract

Background and Objective: A strong association has been reported between extended cutting intervals and increased dry matter yields with declined nutritional quality, leaf proportion, and high fibre content. The age of plants has been reported to have significant effects on the yield and quality of forages. Materials and methods: The experiment was a 3 x 2 factorial arrangement laid out as a randomized complete block design. The three varieties of C. purpureus (local green, local purple and F1 hybrid), and two harvesting ages (4 and 8weeks after cut back (WAC)) were factors in this experiment. All data collected were subjected to two-way analysis of variance. Results: There were significant ($p<0.05$) differences in the agronomic growth trait values of C. purpureus varieties as affected by age at harvest. At 8 weeks, the plants had significantly higher ($p<0.05$) plant height (105.43cm), leaf length (78.27cm), leaf width (2.38cm), number of leaves (123.52cm), and number of tillers(24.35cm) than at 4 weeks. The leaf expansion (13.05cm) and elongation (0.49cm) rates were significantly higher ($p<0.05$) at 4 weeks than at 8 weeks. At 8weeks, the plants had significantly higher ($p>0.05$) fresh yield (12.19 Kg/ha), dry matter yield (8.06 Kg/ha), leaf dry matter yield (3.50 Kg/ha), and stem dry matter yield (4.55 Kg/ha) compared to 4 weeks. Local green C. purpureus variety having significantly higher ($p<0.05$) leaf to stem ratio (L: S) (0.81Kg/ha) while F1 and purple variety produced similar number (0.74Kg/ha) of L:S. Conclusion: C. purpureus at 8 weeks after cutback produced highest agronomic characteristics, dry matter yield. The local green variety recorded the highest Leaf: Stem ratio.

Keywords: Cenchrus purpureus; varieties; growth trait; dry matter yield; age at harvest

Introduction

Pasture and fodder remain the cheapest forms of animal feed [1]. The ideal pasture and fodder species should be high yielding, palatable and contain adequate levels of highly digestible nutrients to satisfy the requirements of livestock [2]. Cenchrus purpureus (Elephant grass) also known as Napier grass, has been the most promising high-yielding fodder, giving dry matter (DM) yields that surpass most of other tropical grasses [3] suggested that the use of sown and purposely managed pastures could help raise ruminant productivity. Harvesting grasses at a stage that would be consistent with maintaining high dry matter yield and optimum quality is therefore essential. The objective of this study is to determine the effect of age at harvest (4 and 8weeks after cutback) and varieties

(local green, local purple and F1 hybrid) on the growth trait and yield of Cenchrus purpureus.

Materials and Methods

Study area

The field experiment was carried out at the Directorate of University Farms and the chemical analysis was carried out at the laboratory of the Department of Pasture and Range Management, College of Animal Science and Livestock Production, Federal University of Agriculture, Abeokuta (FUNAAB), Ogun State, Nigeria. The area is located in the humid tropical zone of South-Western Nigeria with minimum and maximum temperature of 20.66°C and 35.48°C respectively. It lies in the in region 76 mm within latitude 7o 10' N, longitude 3o 2' E, it receives a mean precipitation of 1037mm per annum (FUNAAB Agrometeorological station, 2020).

Sourcing of C. purpureus varieties

Stem cuttings of the C. purpureus varieties were sourced from an already established plot at the Introduction plot of the Department of Pasture and Range Management Farm, FUNAAB. This was cut to about 30 cm long consisting between three to four nodes.

Land preparation and Experimental layout

Land area measuring 480 m2 was cleared, ploughed, harrowed, and stumped manually. The debris after land clearing operations were packed away from the plot. A total of 18 plots were mapped out for all block treatments. Six plots per block were demarcated with each plot comprising of nine stands. Growth data was randomly taken each on three stands per plot across all blocks. The land was divided into three blocks, each measuring 3m x 30 m (90 m^2) and were further divided into plots measuring 3m x 3m (9 m^2) with a 2 m buffer zone between plots and blocks.

Fertilizer Application

Poultry manure was used as fertilizer in this study. The droppings of layer chicken fed layers mash were collected without wood-shavings. The collected manure was air-dried and analyzed to determine its nutrient composition. The manure was applied immediately after cutback at a rate of 400 kgN/ha.

Sourcing of the plant materials and planting

Stem cuttings of the C. purpureus varieties were sourced from an already established plot at the Introduction plot of the Department of Pasture and Range Management Farm, FUNAAB. This was cut to about 30 cm long consisting between three to four nodes. Planting of the materials was done the same day as collection. Dead materials were re-supplied. Four weeks after planting new shoots were cut back to allow even regrowth.

Agronomic data collection

At 4 and 8 WAC, the designated age of growth, agronomic (Measurement of plant height, leaf length and width (cm), counting of number of leaves and tillers, determination of dry matter yield) data were taken followed by harvesting at 15 cm above ground level.

Determination of dry matter yield

The C. purpureus varieties were harvested at 4 and 8 WAC using a 1.0 m × 1.0 m quadrat. In each quadrat area samples, the above ground vegetative plant material was harvested from 15 cm above ground level. The harvested grasses were weighed (Fresh weight (FW) and sub-sample of 500g was taken and oven dried at 65oC until constant dry weight (DW) was attained to obtain the dry matter percentage. The dry matter percentage was calculated using the formula below:

$$Dry\ matter\ percentage\ (\%) = \frac{DW}{FW} \times 100$$

The dry matter yield was calculated using the equation below: Dry matter yield (%) = dry matter percent x weight of fresh sample from 1.0 m2 which afterwards was extrapolated in tons per hectare.

Statistical analysis

All data obtained was subjected to two-way analysis of variance using the general linear hypothesis testing (GLHT) package of the R Statistical Software [4]. Mean values were separated using Tukey's HSD test.

Results

There were significant ($p<0.05$) differences in the agronomic growth trait values of the Cenchrus purpureus varieties as affected by the age at harvest (Table 1). At 8 weeks, the plants had significantly higher ($p<0.05$) plant height, leaf length, leaf width, number of leaves, and number of tillers than at 4 weeks. The leaf expansion and elongation rates were significantly higher ($p<0.05$) at 4 weeks than at 8 weeks. The observed leaf length and number of leaves varied ($p<0.05$) with varieties of C. purpureus. The green Cenchrus purpureus variety produced significantly ($p<0.05$) longer leaves than the F1 variety only but produced the least ($p<0.05$) number of leaves of the three varieties. The F1 and purple Cenchrus purpureus varieties produced similar ($p>0.05$) number of leaves. The green and purple varieties had higher ($p<0.05$) leaf expansion rates than the F1 variety, however, only the green variety had a higher ($p<0.05$) leaf elongation rate than the F1 variety. There were significant ($p<0.05$) differences in the yields of the Cenchrus purpureus varieties (Table 2). At 8 weeks, the plants had significantly higher ($p<0.05$) fresh yield, dry matter yield, leaf dry matter yield and stem dry matter yield than at 4 weeks. The leaf expansion and elongation rates were significantly higher ($p<0.05$) at 4 weeks than at 8 weeks. The effect of the varieties was significant ($p<0.05$) on the leaf: stem (L:S) only. The green C. purpureus variety produced significantly ($p<0.05$) higher leaf: stem than the F1 and Purple variety which produced similar number of L:S.

Table 1: Effect of age at harvest on growth parameters of *Cenchrus purpureus* varieties.

Parameters	pH	LL	LW	NOL	NOT	PER	LExR	LEIR	LAR	TAR
Age	cm					cm				
4	57.39^{b}	52.21^{b}	1.95^{b}	75.90^{b}	14.94^{b}	14.35	13.05^{a}	0.49^{a}	18.98	3.74
8	105.43^{a}	78.27^{a}	2.38^{a}	123.52^{a}	24.35^{a}	13.18	9.79^{b}	0.30^{b}	15.44	3.04
SEM	5.63	4.11	0.12	12.46	1.82	1.01	0.74	0.02	2.11	0.30
Variety F1	77.32	52.56^{b}	2.06	134.69^{a}	20.11	12.29	9.03^{b}	0.35^{b}	21.16^{a}	3.20
Green	91.32	77.33^{a}	2.37	54.67b^{b}	16.47	15.69	13.48^{a}	0.45^{a}	10.42^{b}	2.90
Purple	75.59	65.83^{ab}	2.07	109.78^{a}	22.35	13.32	11.75^{a}	0.39^{ab}	20.05^{a}	4.06
SEM	8.95	5.39	0.15	13.08	2.06	1.07	0.81	0.03	2.21	0.33
P-Value Age	<.0001	<.0001	0.0044	0.0011	0.0011	0.3569	0.0006	<.0001	0.1145	0.1001
Variety	0.1611	0.0008	0.1424	<.0001	0.2111	0.0864	0.0007	0.0078	0.0003	0.0684
Age X Variety	<.0001	<.0001	<.0001	<.0001	0.0090	<.0001	<.0001	<.0001	<.0001	0.0013

ab: Means with different superscripts along the same* column is significant (P<0.05)

pH= Plant height, LL= Leaf length, LW= Leaf width, NOL= Number of leaf's, NOT= Number of tillers PER= Plant elongation rate, LExR= Leaf expansion rate, LEIR= Leaf elongation rate, LAR= Leaf appearance rate, TAR= Tiller appearance rate

Table 2: Effect of age at harvest on agronomic yield of *Cenchrus purpureus* varieties.

Parameters	Fresh Yield	Dry matter	Dry matter yield	L:S	Leaf dry matter yield	Stem dry matter yield
Age	Kg/ha					
4	6.72^{b}	0.67	4.59^{b}	0.76	2.01^{b}	2.58^{b}
8	12.19^{a}	0.67	8.06^{a}	0.76	3.50^{a}	4.55^{a}
SEM	0.75	0.01	0.49	0.01	0.23	0.26
Variety F1	9.46	0.65	6.17	0.74^{b}	2.65	3.51
Green	10.38	0.68	6.83	0.81^{a}	3.06	3.77
Purple	8.52	0.69	5.98	0.74^{b}	2.56	3.43
SEM	1.17	0.02	0.76	0.02	0.34	0.42
P-Value Age	<.0001	0.9328	0.4742	0.9640	<.0001	<.0001
variety	0.2296	0.3103	<.0001	0.0046	0.2919	0.6651
Age x variety	<.0001	<.0001	<.0001	0.0315	<.0001	<.0001

Discussion

The observed preference for plant elongation, leaf elongation or leaf expansion in different grasses investigated revealed the mechanism the plants used to capture sufficient light for photosynthesis. In the F1 hybrid variety, more attention was placed on leaf appearance rate above other traits. This suggests that plant pattern has to do with an adaptive feature which enables increased light capture under low sunlight conditions [5]. However, different for the local green variety, which prioritize more in leaf elongation, and leaf expansion rates over leaf appearance. According to [6], the action of the grass permits a better distribution of light inside the canopy and prevents etiolating of the lower leaves. However, the differences in the trait values observed for the varieties shows that the morphogenic traits of the varieties is determined by their genetics (i.e., differences in their varieties) rather than the environment, since they all grown under the same environmental condition. Increments in plant height at 8weeks harvest stage could be due to massive root development and efficient nutrient uptake, allowing the plant to continue to increase in height as mentioned by [7] showed that total herbage yield in Elephant grass increased with increase in harvesting age (60<90<120 days), which is also attributed to the increase in tiller number, leaf formation, leaf elongation and stem development. Similarly, reported that yield of Bana grass increased as harvesting stage increased.

The observed high number of leaves per plant at 8weeks of harvesting in this present study is in line with the findings of [8] with the same grass species, with Bana grass and [9] with Napier grass. Generally, the taller the plant, the greater the number of leaves produced [10] which is in line with the present study as the number of leaves from new tillers generally increased with increase in age at harvesting. There was variation in the dry matter yield values of the plants across the weeks of growth. However, dry mat-

ter accumulation is often influenced by plant choice investments in stem or leaf traits, and this can vary based on the stage of growth a plant has attained [11]. Although there were no differences in the dry matter yield obtained for the three varieties across the seasons in this study, it is important to point out that the better yield traits recorded for the local green variety, may be due to the fact that it is better adapted to the environment. The leaf to stem ratio (LSR) is one of the criteria in evaluating the quality of the pasture grass because the higher proportion of leaves compared to stem indicates a better nutritive value. Yield is important since in tropical crops, like C. purpureus, forage quality diminishes during the dry season, but it increases during the rainy season [12].

Conclusions

a) *Cenchrus purpureus* at 8weeks after cutback produced the highest agronomic characteristics (plant height, leaf length, leaf width, number of leaves, plant elongation rate, and leaf expansion rate) and dry matter yield.

b) The local green variety recorded the highest Leaf: Stem ratio.

Competing Interest

The authors have declared that no competing interest exists.

Data Availability

All relevant data are within the paper and its supporting information files.

References

1. Shinde AK, Mahanta SK, (2020) Nutrition of small ruminants on grazing lands in dry zones of India. Range Manag Agrofor 41(1): 1-14.
2. Fulkerson WJ, Neal JS, Clark CF, Horadagoda A, Nandra KS, et al. (2007) Nutritive value of forage species grown in the warm temperate climate of Australia for dairy cows: grasses and legumes. Livest sci 107(2): 253-264.
3. Ansah T, Osafo ELK, Hansen HH (2010) Herbage yield and chemical composition of four varieties of Napier (Pennisetum purpureum) grass harvested at three different days after planting. Agric Biol J North Am 1(5): 923-929.
4. R Core Team R (2018) R: A language and environment for statistical computing.
5. Klich MG (2000) Leaf variations in Elaeagnus angustifolia related to environmental heterogeneity. Environ Exp Bot 44(3): 171-183.
6. Gomide CAM, Paciullo DSC, Costa IA, Lima AM, Castro CRT, et al. (2011) Morphogenesis of dwarf elephant grass clones in response to intensity and frequency of defoliation in dry and rainy seasons. Revista Brasileira de Zootecnia 40(7): 1445-1451.
7. Melkie B, Melaku S (2010) Effect of planting patterns and harvesting days on yield and quality of Bana grass [Pennisetum purpureum x Pennisetum americanum]. The IUP Journal of Life Sciences.
8. Tilahun G, Asmare B, Mekuriaw Y (2017) Effects of harvesting age and spacing on plant characteristics, chemical composition and yield of Desho grass (Pennisetum pedicellatum Trin.) in the highlands of Ethiopia. Trop Grassl-Forrajes 5(2): 77-84.
9. Zewdu T, Baars RMT, Yami A (2002) Effect of plant height at cutting, source, and level of fertiliser on yield and nutritional quality of Napier grass (Pennisetum purpureum (L.) Schumach.). Afr J Range Forage Sci 19(2): 123-128.
10. CO M, MAO O, BA K (2007) Effect of maize planting density on the performance of maize/soybean intercropping system in a guinea savannah agroecosystem. Afr J Agric Res 2(12): 667-677.
11. Paciullo DSC, Fernandes PB, Gomide CAM, Castro CRT, Souza Sobrinho FS, et al. (2011) The growth dynamics in Brachiaria species according to nitrogen dose and shade. Revista Brasileira de Zootecnia 40(2): 270-276.
12. Ojo VOA, Ojambati GO, Adeleye TK, Badaru SO, Oduyemi OO, et al. (2015) Effects of seasonal variation on the chemical characteristics of Pennisetum purpureum varieties fertilized with manures. Journal of Organic Agriculture and Environment 3: 97-107.