



Effect of post-planting period on yield of irrigated Bermuda grass (*Cynodon dactylon*) in Bauchi State

Sani, I*.¹, Adamu, A.¹, Musa, S.¹, Girgiri, A. Y.²

¹Department of Animal Production, Abubakar Tafawa Balewa University, Bauchi, Nigeria.

²Department of Animal Science, University of Maiduguri, Borno State, Nigeria

Abstract

This study was conducted during the dry season to investigate the dry matter yield and chemical composition of Bermuda grass (*Cynodon dactylon*). The test materials were grown at Abubakar Tafawa Balewa University, Bauchi in 2020 and 2021 dry seasons. *C. dactylon* was established on a 3.5 ha paddock by transplantation of sprigs from the wild and experimental plots received sprinkler irrigation twice-weekly. The dry matter yield (t/ha), leaf dry matter (%), stem dry matter (%) and total dry matter (%) were measured. The chemical composition of the grass was also determined. The results obtained indicated that *Cynodon dactylon* at 12 weeks after transplanting had higher yield (4.08 t/ha) which was significantly different ($P < 0.01$) from other weeks. Results for leaf dry matter followed same pattern as dry matter yield, while stem and whole plant dry matter (%) were higher ($P < 0.01$) in *C. dactylon* at week 12 (49.20 and 46.17% respectively). Chemical composition decreased as plant matured from week 4 to week 12 while mineral elements examined were not significantly influenced by post-planting period as weeks increased and plant matures. Irrigated Bermuda grass had highest dry matter yield at week 12 and best mineral contents compared to other weeks, while week 4 had the best nutritive values from chemical composition. Hence, it is recommended that irrigated *Cynodon dactylon* be harvested at 12 weeks after transplanting.

Keywords: Paddock, Sprigs, prediction equation, transplantation, weeks, irrigation

Introduction

Pastoralists employed livestock mobility as the main mechanism of adapting to the feed deficits during the dry season. (Bruce, 2003) This strategy is increasingly becoming untenable today due to a wide array of socio-economic, political and anthropogenic factors such as extension of crop farming and human settlements (cities and towns) in the rangelands and also clashes in the form of farmers-herders conflict (Kumar, 2016).

Large-scale cultivation, harvesting and storing of the forage in form of hay to be utilized during the dry season, when the open pasture has been depleted, has been cited as a potential strategy for bridging livestock feed deficits and adapting to climate change in the dry lands (McCarty *et al.* 2002). However, evaluation of

pasture species to identify the most productive and adapted species under the arid and semi-arid range lands has not been comprehensive (Biwas and Yadav, 2004). In view of this, there is need to evaluate indigenous pastures that is drought tolerant and could improve productivity in ruminants, which warranted evaluating the yield of Bermuda grass (*Cynodon dactylon*) in this study. *Cynodon dactylon* is a rhizomatous or stoloniferous perennial grass found in warm temperature, tropic and sub-tropical areas (Santos and Boecheat, 1994). Bermuda grass (*Cynodon dactylon*) is highly tolerant to drought and heavy grazing, and therefore extremely valuable for pasture in Northern Nigeria. Forage leaves contain considerably more protein and less fibre than the stems, so as forage matures and the stem becomes more

prevalent and fibrous, quality decreases and the plant become less digestible (Anderson, 2012).

Though, there is generally little or no information on the establishment of *Cynodon dactylon* under irrigation, this information is needed for making sustainable management of pastures during dry season due to scarcity and poor quality of forages. Hence, this research work is aimed at determining the dry matter yield and yield content of irrigated *Cynodon dactylon* established by sprig transplant in Bauchi, Nigeria.

Materials and Method
Study Location

This study was conducted at Abubakar Tafawa Balewa University Bauchi, Nigeria, located on altitude of 640 m above sea level. Bauchi, a state in North Eastern part of Nigeria, located at geographical coordinates of 10°33' N and 9°31' E. The state lies within the guinea savannah of the ecological zone with an annual rainfall of between 1000 mm and 1300 mm per annum. Relative humidity ranges from about 12% in February to about 68% in August. At the beginning of the rainy season, relative humidity is about 37% (BSG, 2009).

The experimental soil is loamy sand and its characteristics are shown in the Table 1 while Rainfall, Temperature and relative humidity of the experimental area are presented in Table 2.

Table 1: Soil characteristics of the experimental site

Properties	Values
Physical properties	
Particle Size (%)	
Clay	10.8
Silt	18.3
Sand	71.17
pH	6.36
Chemical properties	
Total N (%)	0.10
Zn (ppm)	2.50
P (ppm)	9.30
Exchangeable cations (meg/100g of soil)	
Ca ⁺⁺	6.65
Mg ⁺⁺	3.18
k ⁺	9.52
Na	26.60

Field study, 2020

Experimental Design and Management of established pastures

The *Cynodon dactylon* was established at Abubakar Tafawa Balewa University, Bauchi in 2020 and 2021 growing season and the mean of the two seasons was used as data for this study. *Cynodon dactylon* was established on a 3.5 ha paddock during the dry seasons (November – February) of 2020 and 2021. The

land was prepared by ploughing once and harrowing twice and vegetative materials or springs were transplanted at 50 cm interval on the prepared land. The planted area was weeded 2 weeks after establishment. A mixture (1:2) of urea (46%N) and NPK (20:10:10) fertilizer was applied at the rate of 100 kgN/ha. The fenced paddock was closed to prevent grazing by animals. The first

fertilizer dose was applied at first weeding (week 2) while second fertilizer dose were applied 4 weeks after the initial fertilizer application and measurements and sampling of pastures commenced 4 weeks after establishment and was done fortnightly. Plots

received sprinkler irrigation with not less than 25 mm of water applied at a single irrigation with the irrigation done fortnightly and the source of water was from a farm pond close to the experimental area.

Table 2: Temperature, Relative Humidity and Rainfall Distribution of the Experimental Site.

Months	Maximum Temp. (°C)		Relative Humidity (%)		Rainfall (mm)	
	2020	(2015-2019)	2020	(2015-2019)	2020	(2015-2019)
May	33.7	34.1	47.9	49.2	120.6	112.3
June	31.5	31.0	55.2	57.0	147.9	137.6
July	30.5	29.9	63.2	62.3	159.6	142.5
August	31.3	30.2	71.3	69.2	197.6	210.0
September	31.9	31.4	67.6	70.1	241.2	277.7
October	33.4	31.9	61.2	65.5	51.7	62.8
Total	228.7	225.5	387.8	396.9	914.3	982.1
Mean	32.7	32.2	55.4	56.7	130.6	140.3

Source: ATBIA (2020)

Dry matter yield and plant part contents

Cynodon dactylon were cut at a height of 10 cm to enable re-growth of cut areas. Total fresh material cut per 1 m² quadrat was immediately weighed (Tot. FW) to determine the fresh forage yield per quadrant in each treatment and a sub-sample of 250 g taken for oven drying to determine the dry weight. The dry matter yield production during the period was estimated using the procedure of Tarawali *et al.* (1995).

In addition, the total harvested herbage in each quadrant was weighed fresh before and after sorting out the trial pasture from the weeds. A sample of the harvest from each quadrant was weighed and the dry matter determined in an oven at 60°C for 48 hours. Sub-samples were taken in which the leaves were separated from the stem and the dry matter (%) of the parts determined for each pasture species. The average total dry matter yield (t/ha) and the parts dry matter were calculated as the mean of all weeks.

Chemical Analysis to determine the quality of forage samples

B. ruziziensis and *C. pascuorum* were cut at week 10 and 12 in this study for chemical analysis. The forage sub samples of *B. ruziziensis* and *C. pascuorum* were taken to the laboratory for oven drying and chemical analysis. Nitrogen content (N) of the forages was determined using Kjeldahl method, the protein content was calculated by multiplying the nitrogen content by a factor of 6.25 (N x 6.25). The total ash content was determined by procedure of AOAC (2005), while Van Soest method of forage analysis was used to determine Neutral Detergent Fibre (NDF) and Acid Detergent Fiber (ADF). Hemicellulose was determined as difference between neutral detergent fibre and acid detergent fibre.

Experimental Design and Analysis

The Data generated was subjected to Analysis of variance in a Randomized Complete Block Design (RCBD) with the sampling period as treatment (SAS, 2005). Duncan's Multiple Range Test (DMRT_{0.05}) was used to determine significant difference (P<0.05)

between treatment means. The procedures for correlation and regression of SAS (2005) were used to compute predictive equations for dry matter with maximum temperature and humidity as the independent variables.

Results

Table 3 shows the effect of sampling period on dry matter yield (t/ha) and component dry matter of irrigated *Cynodon dactylon*. Sampling period had significant ($P<0.01$) effect on the dry matter yield, leaf dry matter, stem dry matter and total dry matter. The least value obtained were in the first four weeks post-planting while week 12 post-planting had the highest values for each of the parameters measured. The dry matter yield progressively increased from 2.56 t/ha in week 4 to 4.08 t/ha in week 12, dry matter yield (t/ha) had significant difference ($P<0.01$) across weeks

with week 4 & 6 and week 8 & 10 having statistically same value. Values for corresponding leaf dry matter were significant ($P<0.01$) except between week 10 & 12 and ranged from 34.63 to 43.81% in week 4 to 12, respectively.

Similarly, the stem dry matter increased ($P<0.01$) from 37.56% in week 4 to 49.20% in week 12 and the corresponding total dry matter (t/ha) ranged from 30.60 to 46.17%, respectively. Generally, parameters measured progressively increased from week 4 to week 12. In Table 4, equations to predict dry matter yield from Maximum temperature and Relative humidity are given. There was a positive relationship between dry matter yield and maximum temperature or average relative humidity or Rain days for *Cynodon dactylon* ($R^2 = 0.94$ or 0.84).

Table 3: Effect of period (post-planting) of sampling on dry matter yield (t/ha) and component dry matter (%) of *Cynodon dactylon*

Period (weeks)	DM Yield (t/ha)	Leaf DM (%)	Stem DM (%)	Total DM (%)
4	2.56 ^c	34.63 ^d	37.56 ^e	30.60 ^e
6	2.83 ^c	40.62 ^c	38.96 ^d	37.00 ^d
8	3.40 ^b	40.72 ^c	44.46 ^c	41.89 ^c
10	3.52 ^b	42.97 ^a	47.75 ^b	42.91 ^b
12	4.08 ^a	43.81 ^a	49.20 ^a	46.17 ^a
Mean	2.94	40.55	43.59	39.72
SEM	±0.50	±0.73	±0.28	±0.53

^{a,b,c} = Means on the same row with different super script are significantly ($P<0.01$) different, DM = Dry matter, SEM = Standard Error of Mean.

Table 4: Prediction equation for dry matter yield from Maximum temperature (°C) and Average relative humidity

Estimation	Equation	Adjusted R ²
Maximum temperature	$Y=2.55x \pm 1.021^{**}$	0.93
Average relative humidity	$Y=0.10x \pm 0.085^{**}$	0.82

^{**} $P<0.01$, X= Maximum temperature (°C) or Average Relative Humidity. Y= Dry matter yield (t/ha).

Nutritive value of irrigated *Cynodon dactylon*

The results for chemical composition of irrigated Bermuda grass at different post-planting periods (weeks) are shown in Table below. The results showed that most parameters for chemical

composition except Ether extract and Nitrogen free extract all increased as weeks increased and plant matured. There was significant difference ($P<0.01$) across treatments for crude protein, Acid detergent fibre, Neutral detergent fibre and Nitrogen free extract.

Table 6 showed results for mineral content (%) of irrigated *Cynodon dactylon* at different weeks. Calcium, phosphorus, Potassium, sodium and magnesium contents (%) generally increased as plant age increased from week 4 to week 12. The mean values showed potassium content was highest (5.62%) followed by phosphorus (2.18%) and the lowest value was in magnesium (1.14%).

Table 5: Effect of period (post-planting) of sampling on Chemical composition (%) of irrigated *Cynodon dactylon*

Parameters	Sampling periods (weeks)					Mean	SEM
	4	6	8	10	12		
Dry matter	80.78	89.64	89.76	90.11	90.61	88.18	2.52
Crude protein	10.50 ^a	10.29 ^a	9.24 ^{ab}	8.62 ^{bc}	7.23 ^d	9.18	1.28
Acid Detergent Fibre	21.25 ^a	24.53 ^b	26.74 ^c	28.30 ^d	32.43 ^e	26.65	2.05
Neutral Detergent Fibre	28.21 ^a	31.23 ^b	32.63 ^c	32.68 ^c	38.46 ^d	32.64	1.53
Fibre	1.80	1.20	1.45	1.53	1.63	1.52	0.82
Ether extract	8.24	8.69	8.67	10.39	11.86	9.57	1.58
Ash	51.25 ^a	48.59 ^b	48.01 ^b	46.78 ^c	40.82 ^d	47.09	2.28
Nitrogen free extract							

Table 6. The mineral composition (%) of Irrigated *Cynodon dactylon* at different periods of sampling (weeks).

Mineral contents (%)	Sampling periods (weeks)					Mean	SEM	LOS
	4	6	8	10	12			
Calcium	0.10	0.15	0.23	0.41	0.61	1.50	0.58	NS
Phosphorus	0.22	0.21	0.25	0.29	1.21	2.18	1.03	NS
Potassium	0.90	0.93	1.11	1.23	1.45	5.62	0.89	NS
Sodium	0.10	0.07	0.06	0.10	1.12	1.45	1.20	NS
Magnesium	0.16	0.16	0.18	0.21	0.43	1.14	0.73	NS

NS = Not Significant at $P<0.01$

Discussion

In Table 2, the dry matter yield for irrigated Bermuda grass (*Cynodon dactylon*) obtained in this study was comparable with the range of 1.58 to 4.62 t/ha earlier reported for various cultivars of ranfed *Cynodon dactylon* (kanno et

al, 2009). Higher yields of 7.3 to 13.4t/ha have however been reported (Woodard and Sollenberger, 2011). The higher yield may be attributed to differences in cultivars level of fertilizer application and age of plant establishment (Sani et al., 2020)

The dry matter yields of irrigated *Cynodon dactylon* was lower than values obtained for rain fed probably because of the season of establishment. Burton *et al.* (1988) reported that coastal Bermuda grass will produce little forage after September regardless of the amount of fertilizer and water supplied. He also reported that applying water and Nitrogen fertilizer for increased fall production will give a much lower response compared to other seasons.

There was a progressive increase in dry matter yield and content of the leaf, stem and whole plant with advancement in period because the plant matured more with changes in weeks (Minson, 1990). Stepwise increase in yield as weeks increased indicated that weeks of growth was the single most important variable related to yield.

Mean temperature and humidity had positive relationship with yield in this study, this is probably connected to solar radiation and photosynthesis. It was reported that increase in yield with corresponding sun light and temperature was due to increase in the photosynthetic rate relative to the respiration rate (McBee and Holt, 2012; Mckell *et al.*, 1986). This corroborates the finding of Burton *et al.*, (1993) that daylength and solar radiation but not rainfall and minimum temperature were significantly correlated with forage yield.

Chemical composition of irrigated Bermuda grass (*Cynodon dactylon*) indicated nutrient components except ether extract and nitrogen free extract increased as week increased. Nutrient content decreases in forages as the plant matures and age increases (Anderson, 2012; Sani *et al.*, 2020). The variation in fibre fraction in the early stage of plant growth and in the late stage might be due to difference in maturity, stage of growth and lignin content of plant (Fadiyimu *et al.*, 2011).

Mineral content of forages is greatly influenced by the quantity and availability of minerals in soil. Aside phosphorus (P) and Sodium (Na) at week 4, result for mineral contents in *Cynodon dactylon* in this study increased with plant maturity which corroborates earlier finding (McDowell, 1985).

Conclusion

The results of this study indicated that irrigated Bermuda grass had higher dry matter yield at week 12 and better mineral contents compared to other weeks, while week 4 had the best nutritive values from chemical composition. Irrigation ensured sustainable production of *Cynodon dactylon* with good nutritive value for animals during dry season period, hence it is recommended that irrigated *Cynodon dactylon* be harvested at week 12. Furthermore, research on irrigated Bermuda grass should be conducted to determine the best type of irrigation system (flooded or sprinkler) for the grass in Bauchi, Nigeria.

References

- Anderson, H. (2012). What factors affect forage quality. Anderson company Extension Report. Co. Inc. Retrieved from www.anderson-hay.com on Tuesday 20th December, 2021
- AOAC. (2000). Association of Official Agricultural Chemist. *Official Methods of Analysis*, Virginia, USA.
- .ATBIA (2020). Abubakar Tafawa Balewa International Airport Bauchi, Weather Report.
- Biwas H.S and Yedav G.C (2004). Animal drawn weeding tools for weeding inter-cultural. In: Black Soil Grass. *Agricultural Engineering Today* **28** (12):47-53
- Bruce, W.B., Edmeades, G.O., Baker, T.C. (2003). Molecular and physiological approaches to maize improvement for

- drought tolerance. *J. Exp. Bot.*, 53:13-25
- BSG (2009). Bauchi State Government of Nigeria Diary. Published by Bauchi State Government of Nigeria.
- Burton, G.W., Hook, J.E, Butler, J.L and Hellwig, R.E. (1988). Effect of Temperature, Daylength and Solar radiation on production of coastal Bermuda grass. *Agron. J.* 80:557-560
- Burton, G. W. (1993). African grasses. In: J. Janick and J. E. Simon (eds). *New Crops*. Wiley, New York.
- Burton, G.W., Gates, R.N. and Hill, G.M. (1993). Registration of 'Tifton 85'. Bermuda grass. *Crop Sci.* 33 (3):2.
- Kanno, T., Fukuyama, M., Ato, S. and Suda, K. (2009). Performance several Bermuda grass cultivars (*Cynodon dactylon L.*) screened for winter hardness in Japan, *Bulletin of the national Grassland research institute* 46:1-12
- Kumar P. Singh Y. and Kumar R. (2006). Productivity profitability nutrient uptake and soil health of Bermuda grass as influence by cultivars and herbicides. *International Journal of Agriculture and Statistical Science.* 12(1):177-185
- McBee, G. and Holt, F. (2012). Shade tolerance studies on Bermuda grass and other turf grasses. *Agronomy journal.* 58:523-525
- McCarty, L.B., and G. Miller (2002). Managing Bermuda grass turf. *Sleeping bear press*, Michigan, USA
- McDowell, L.R. (1985). Nutrient requirements of ruminants. In: McDowell, L. R. *Nutrition of grazing ruminants in warm climates*. Academic Press, Orlando, FLKA. USA. Pp21-43
- McKell, C. M., Youngner, B. B., Nudge, F. J. and Chatterton, J. J. (1996). Carbohydrate accumulation of coastal Bermuda grass and Kentucky blue grass in relation to temperature regimes. *Crop Science Journal.* 534-537.
- Minson, J. (1990). *Forage in Ruminant Nutrition*. Academic Press Inc. Harcourt Brace Jovanovich, Publishers, San Diego, pp 9-59.
- Oudhia, P., Joshi, B. S. and Kosta, V. K. (1998). The possibilities of preparing homeopathic drugs from the obnoxious weeds of chattisgarh Bhartiya. *Krishi Anusandhan Patrika* 13 (1/2):53-57.
- Ovimaps (2016). Ovi location map: Ovi earth imagery data.
- Sani, I., Amodu, J. T., Tanko, R. J., Hassan, M. R., Adamu, N. and Girgiri, A. Y. (2020). Yield and Quality of *Brachiaria ruziziensis* (Congo Grass) and *Centrosema pascuorum* (Centro) Mixtures as influenced by Mixture Ratios, Phosphorus Levels and Stage of Harvest. *Nigerian Journal of Animal Science and Technology* 3(3):72-85.
- Santos, A., Boechat, S. (1994). *Cynodon (Poacene chloridoidene)* in Rio Grande Brazil. *Iheringia Serie Botanica* 44:85-102.
- SAS (2005). *Statistical Analysis Systems*. SAS Institute, Cary, NC.
- Tarawali, S.A., Tarawali, G., Larbi, A. and Hanson, J. (1995). Methods for the Evaluation of forage legumes, Grasses and Fodder trees for use as livestock feed. *ILRI Project Report*, ILRI (International Livestock Research Institute), Nairobi, Kenya.
- Woodard, K. R., and L. E. Sollenberger (2011). Broiler litter vs. ammonium nitrate as nitrogen source for bermudagrass hay production: Yield, nutritive value, and nitrate leaching. *Crop Sci.* 51(3): 1342-1352