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EVALUATION OF AGRONOMIC PERFORMANCE AND CHEMICAL COMPOSITION OF THREE FORAGE GRASSES INFLUENCED BY IRRIGATION AND HARVESTING AGE IN THE DERIVED SAVANNA ZONE OF NIGERIA

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ABSTRACT

The rate at which climatic variations affect productivity of forage in the tropics demand the need to improve its production in order to meet up with animal requirements. A study was conducted to evaluate the growth and chemical composition of irrigated *Brachairia decumbens* (Bd), *Panicum maximum* (Pm) and *Pennisetum purpureum* (Pp) at the Teaching and Research Farm, Ladoke Akintola University of Technology, in the derived savanna zone Ogbomoso (Latitude 8^0N, Longitude 4^0E). The experiment was carried out using a 2 × 3 factorial design with two daily irrigation (0.6 and 1.2 L) and three harvesting periods (8, 12 and 16 weeks after planting - WAP) in three replicates. Data on plant height was taken at the harvesting stages while herbage samples were randomly collected for dry matter and crude protein determination. Results revealed highest ($p<0.05$) plant height for Bd (67.90cm), Pm (161.20cm) and Pp (85.79cm) for 1.2L 16WAP, while least values (35.84cm, 45.95cm and 35.97cm), respectively, occurred in 0.6L 8WAP. The dry matter and crude protein were significantly different ($p<0.05$). 0.6L16WAP had highest DM (65.49 and 58.51%) for Bd and Pm, respectively while 1.2L16WAP had highest DM (59.96%) for Pp. Their corresponding least values were recorded for 1.2L8WAP. Crude protein contents decreased with increasing cutting ages. 1.2L8WAP had highest CP for Bd (10.50%) and Pp (14.88%) while 0.6L12WAP recorded highest CP (10.51%) for Pm. The examined forage grasses effectively responded to irrigation.

Keywords: Agronomic performance, Grass, Irrigation, Proximate analysis

INTRODUCTION

Ruminant animal in Nigeria depends majorly on natural pastures which are characterized by low yield and poor quality forage materials (Tian *et al*., 2000). Likewise, seasonal variations affect soil nutrient availability for forage species uptake (Ezenwa *et al*., 1995), as soil nutrients availability is essentially controlled by the presence and amount of moisture in the soil. Hence, the nutritional contents of forage species are usually low in the dry seasons compared to the wet seasons (Buxton, 1996). The yearly scarcity of adequate quality and quantity of feeds in dry season leads to the malnutrition in several livestock farms in the derived savanna agro-ecological zone of Nigeria. This situation calls for alternative means of producing forages in the dry season to mitigate against the yearly hardship facing the animals and livestock production. McDonald *et al*. (1995) stated that when balanced diets are fed to animals, their productivity is enhanced and they are better fortified to combat diseases as a result of improved immune system. Thus, the supply of nutrients to animals can be improved by cultivation of proven forage species (Bayble *et al*., 2007) with effective irrigation system to aid the targeted quality and quantity for dry season production. it had been

related that the productivity, chemical composition and nutritive value of forages found in Nigeria vary greatly according to species, the nature and fertility of the soil, water relations, season, disease control and the stage of growth at which the forage species are cut or grazed (Aregheore, 1996; Nuru, 1996). Numerous studies on the yield, growth and chemical composition of *Brachiaria decumbens*, *Panicum maximum* and *Pennisetum purpureum* have been documented (Ajayi and Babayemi, 2008; Dele, 2008; 2012; Dele *et al.*, 2016; Ojo *et al.*, 2013; 2015; Olanite *et al.*, 2006; 2014; Olorunnisomo and Fayomi, 2011), but their cultivation and evaluation under irrigation of any kind in the dry season has not been a common practice in this region. It is important that studies are targeted towards quality production to alleviate feed scarcity in the derived savanna, especially for ruminant animal production. Therefore, this study aims to evaluate the growth and chemical composition of *B. decumbens*, *P. maximum* and *P. purpureum* as influenced by varying quantity of irrigation water and stages of growth in the dry season.

MATERIALS AND METHODS

Experimental Site

The experiment was carried out in late dry season at the pasture plots of the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso (LAUTECH). The University is situated in the Derived savanna zone of Nigeria (Latitude 8^0 8^1 31.7940^{11}N, Longitude 4^0 14^1 42.6696^{11}E). The ambient temperature ranges between 28^0C to 33^0C and relative humidity of about 74% except for January. Monthly and daily rainfalls are characterized by high temporal and spatial variation which ranges from zero (0) to 338mm and over 1673mm per annum and usually occur between April and October with a marked dry season from late October to early April of the following year (Oni *et al.*, 2015).

Experimental design: Land Preparation, Planting and Irrigation

An experimental site measuring 1,140m^2 was mapped out, ploughed, stumped and later partitioned into total of 54 plots. The plots were divided into three blocks of 18 plots each for respective three forages. Each plot measures 4m × 4m, with 1m inter-plots spacing and 1m inter-plants spacing. The experiment was laid in a 2 × 3 factorial experiment using Randomized completely Block design with two factors: daily irrigation water quantity (0.6 and 1.2 L) and harvesting age (8, 12 and 16 weeks after planting (WAP)). The two factors were combined into 0.6L8WAP, 1.2L8WAP, 0.6L12WAP, 1.2L12WAP, 0.6L16WAP and 1.2L16WAP. The six treatment combinations were randomly allotted to the six plots and replicated thrice. Crown split used in establishing the three forage grasses were obtained from an already established paddock at LAUTECH Teaching and Research Farm.

Agronomic Performance, Proximate Compositions and Soil Analyses

At each harvesting stages, three plants were randomly selected per plot for the agronomic data assessment. Plant heights and leaf lengths were measured above ground level with tape rule, while number of tillers per stand and number of leaves per tiller were visually counted. Thereafter, herbage samples of 4 plants per plot were randomly cut on each plot at 10cm above the ground level with knife, oven-dried at 65^{o}C until constant weight and ground in a Wiley mill to pass through 1.0mm sieve screen. Proximate composition of the forages such as dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF) and ash content were determined according to the procedure of (AOAC, 2005). At every period of harvesting, soil samples were randomly taken on each plot with the aid of soil auger at 0 - 15cm depth for the determination of the physico-chemical properties (AES, 1998).

Statistical Analysis

All data collected were subjected to two-way analysis of variance using general linear model of SAS (2000) and the significant ($p<0.05$) treatment means were separated at 5% probability using the Duncan's Multiple Range Test of the same package.

RESULTS AND DISCUSSION

Results

Interaction effect of the varying irrigation water quantity and harvest age on agronomic performance of *B. decumbens, P. maximum* and *P. purpureum* are presented in Table 2. There were significant ($p<0.05$) differences across the interaction of irrigation level and weeks after planting. The highest ($p<0.05$) plant height, tiller number per stand, leaf number per tiller and leaf length were observed for 1.2L16WAP except for *Brachiaria decumbence.* The highest ($p<0.05$) leaf number per tiller (24.15cm) was recorded for 1.2L12WAP. Conversely, the least ($p<0.05$) values for plant height, tiller number per stand, leaf number per tiller and leaf length were observed for 0.6L8WAP. *Panicum maximum* had similar ($p>0.05$) plant height (155.20 vs 155.75cm), tiller number per stand (15.90 vs 15.28) and leaf length (37.52 vs 36.54cm) for 1.2L12WAP and 0.6L16WAP respectively.

Table3 reveals the interaction effect of the varying irrigation water quantity and harvest age on proximate compositions of *B. decumbens*, *P. maximum* and *P. purpureum.* Dry matter content for Brachiaria (65.49%) was highest ($p<0.05$) for 0.6L16WAP while there was comparison within the treatments for Panicum and Pennisetum. *Panicum maximum* was highest but comparable for 0.6L12WAP (57.42%) and 0.6L16WAP (58.51%) while *Pennisetum purpureum* was for 0.6L16WAP (58.51%) and 1.2L16WAP (59.96%). The least ($p<0.05$) DM for the forages were recorded for 1.2L8WAP. Brachiaria recorded the highest crude protein level for 1.2L8WAP (10.50%) while the Panicum and Pennisetum were highest ($p<0.05$) for 0.6L12WAP (10.51%) and 1.2L8WAP (14.88%) respectively. The least ($p<0.05$) values for CP were recorded for 0.6L16WAP except for Panicum. The least ($p>0.05$) crude protein values (7.05 and 7.06%) for panicum were observed for 1.2L12WAP and 1.2L16WAP. Crude fibre and nitrogen free extract had the highest ($p<0.05$) values for 0.6L16WAP while the least values for CF were observed for 0.6L8WAP. The ether extract of Brachiaria (3.48%) was highest ($p<0.05$) for 0.6L12WAP, Panicum (5.82%) for 1.2L16WAP and Pennisetum ($p>0.05$) for 0.6L8WAP (3.32%) and 1.2L8WAP (3.28%). There was similar trend for ash content except for Brachiaria. The highest ($p<0.05$) ash content of Brachiaria (9.67%) was obtained for 0.6L8WAP while the least ($p<0.05$) value (8.10%) was recorded for 0.6L12WAP. Conversely, the highest ash contents for Panicum and Pennisetum were observed for 0.6L12WAP (7.51 and 7.50%) and 0.6L16WAP (7.53 and 7.54%) correspondingly. The least ($p<0.05$) respective values (6.24 and 6.22%) were obtained for 0.6L8WAP.

Discussion

The physic-chemical properties of the experimental soil pH for this study aligned with classification of Fairhurst (2012) as excellent for adequate supply of nutrients to planted forages. This could be averred to the fact that the soil is less predisposed to leaching. Nwachokor *et al.* (2009) reported that high precipitation at the site restructured the chemical structure. Regions of high rainfall, soils even from alkaline parent materials become acidic by leaching away of the basic cations (Ca^{++}, Mg^{++}, K^{+}, Na^{+}) by rainwater and replacement of many by H^{+} (Onwueme and Sinha, 1991). Therefore, the selected forages will like have access to adequate supply of available soil nutrients.

The agronomic performance of the forages in this study were similar to earlier researchers (Alalade *et al.,* 2013b; Sumran *et al.,* 2009) Higher plant heights of the grasses obtained in 1.2L16WAP could be traced to the high nitrogen content of the soil, length of harvest and amount of water used for irrigation as similarly mentioned by Huabin *et al.* (2019). The improved growth of the forages can be attributed to the soil pH which agreed with a similar study (Cook *et al.,* 2005). Water is the essential component of plant cells and is present in most metabolic processes (Vanessa *et al.,* 2020).

Proximate composition of forage is a major determinant of productivity in ruminant animal production (Skerman and Riveros, 1990; Minson, 1990). The increase in the %DM of the three forage grasses with advancing age indicated the increase in the cell wall contents, and this would possibly account for increasing dry matter percentage with increasing interval of harvesting. The CP of *Brachiaria decumbens*, *Panicum maximum* and *Pennisetum purpureum* agreed with the report of other researchers (Nafiatu *et al.,* 2018; Ojo *et al.,* 2013; Rusdy, 2016, respectively). The average of CP percentage of *Pennisetum purpureum* in the current study for 0.6L8WAP and 1.2L8WAP were higher than 12.1 to 12.9% CP reported by Sumran *et al.* (2009) who examined the cutting effect on the same cultivar under irrigation and crude protein level in roughages fed to ruminant animals especially in dry season (Sumran *et al.*, 2009). However, the recorded crude protein values for the three selected forages were higher than 7% CP was a critical level in the forage required for optimum rumen function (Van Soest, 1994; Norton, 1994). Minson (1990) reported that if the CP content of the grass is less than 7%, animal production will be affected due to low voluntary intake, lower rate of digestibility and negative nitrogen balance. In spite the fact that the CP of the selected grasses decreased with age, the intake, digestibility and nitrogen balance will not likely to be affected. The decrease in CP with advancement in age at harvest agreed with the suggestion of Norton (1994) that grass maturity is usually negatively correlated with CP content. Hence, the CP of the three irrigated forages were better than the recommended minimum requirement for ruminant animals in the tropics, hence, irrigation will provide better quality forage for ruminant especially to meet their needs in the dry season. The variation within the treatments could obviously be averred to the age at cutting and level of irrigated water. Tropical forages are characterized by fast lignification and low protein contents as they advance in age (Ajayi and Babayemi, 2008).

The crude fibre of the three forage grasses increased with the age as the crude protein declines with age. The CF of this study agreed with the NRC (2001) requirement for ruminant, and the increase in fibre content as the week of harvest increase can be linked to lignification. It was observed in this study that increase length of cutting and reduced level of irrigation water increased the CF content. This agreed with the submission of Aydinsakir *et al.* (2013) who worked on the influence of regular deficit irrigation applications on water use, yield, and quality components of two corns (*Zea mays* L.) genotypes.

CONCLUSIONS AND RECOMMENDATION

Generally, the three forage grasses effectively responded to irrigation levels in terms of quality and quantity as the age of harvestings advanced, thus made the forages potential feed to confront incessant looming scarcity in dry seasons. Therefore, the grasses are highly recommended for dry season cultivation and feeding of livestock provided the irrigation activities would be keenly followed as shown in this study.

Table 1: Physico-chemical properties of the experimental plots before planting

Properties	Forage grasses	Value±SD
pH	*Brachiaria decumbens*	6.67±0.08
	Panicum maximum	6.27±0.08
	Pennisetum purpureum	4.88±0.10
Organic C (%)	*Brachiaria decumbens*	12.82±0.20
	Panicum maximum	10.77±0.21
	Pennisetum purpureum	8.36±0.34
Total N (%)	*Brachiaria decumbens*	1.77±0.04
	Panicum maximum	1.06±0.06
	Pennisetum purpureum	0.07±0.08
Available P (ppm)	*Brachiaria decumbens*	9.65±0.13
	Panicum maximum	7.63±0.18
	Pennisetum purpureum	7.84±0.11
K (cmol/kg)	*Brachiaria decumbens*	0.64±0.01
	Panicum maximum	0.68±0.03
	Pennisetum purpureum	0.46±0.01
Silt (%)	*Brachiaria decumbens*	80.00±0.23
	Panicum maximum	77.44±0.19
	Pennisetum purpureum	86.41±0.32
Clay (%)	*Brachiaria decumbens*	2.44±0.18
	Panicum maximum	4.13±0.26
	Pennisetum purpureum	3.25±0.27
Sand %)	*Brachiaria decumbens*	17.56±0.34
	Panicum maximum	18.43±0.45
	Pennisetum purpureum	10.34±0.36

Table 2: Effect of varying litres of irrigation water and harvest stages on agronomic performance of *B. decumbens, P. maximum* and *P. pennisetum*

Growth parameters	Forage grasses	0.6L8 WAP	1.2L8 WAP	0.6L12 WAP	1.2L12 WAP	0.6L16 WAP	1.2L16 WAP	SEM
Plant height (cm)	Brachiaria	35.84^{f}	43.30^{e}	52.22^{d}	57.79^{b}	54.74^{c}	67.90^{a}	2.10
	Panicum	45.95^{e}	65.65^{d}	147.35^{c}	155.20^{b}	155.75^{b}	161.20^{a}	3.24
	Pennisetum	35.97^{f}	50.10^{e}	78.71^{d}	82.81^{b}	79.82^{c}	85.79^{a}	0.98
Tiller No. /Stand	Brachiaria	7.10^{f}	13.22^{e}	23.68^{d}	32.75^{b}	30.09^{c}	43.14^{a}	3.18
	Panicum	7.35^{e}	10.37^{d}	13.15^{c}	15.90^{b}	15.28^{b}	17.13^{a}	1.67
	Pennisetum	4.05^{f}	4.27^{e}	6.20^{d}	7.68^{b}	6.59^{c}	10.14^{a}	0.78
Leaf No./Tiller	Brachiaria	5.88^{f}	10.80^{d}	10.25^{e}	24.15^{a}	14.55^{c}	21.30^{b}	0.31
	Panicum	5.42^{f}	6.60^{e}	7.05^{d}	8.72^{b}	7.35^{c}	9.28^{a}	0.82
	Pennisetum	10.71^{f}	10.92^{e}	14.00^{d}	14.10^{c}	14.20^{b}	17.59^{a}	0.17
Leaf length (cm)	Brachiaria	13.80^{f}	16.25^{d}	16.09^{e}	18.38^{b}	16.42^{c}	23.45^{a}	0.21
	Panicum	27.54^{e}	35.32^{c}	33.61^{d}	37.52^{b}	36.54^{b}	41.37^{a}	1.07
	Pennisetum	31.85^{f}	43.05^{e}	61.55^{d}	64.28^{c}	65.52^{b}	68.24^{a}	1.01

$^{a\text{-}f}$: Means in the same column with different superscripts differ significantly ($P< 0.05$); SEM: Standard error of means; Brachiaria = *B. decumbens*; Panicum = *P. maximum*; Pennisetum = *P. purpureum*; 0.6L8WAP = 0.6 litres + 8 weeks after planting; 1.2L8WAP = 1.2 litres + 8 weeks after planting; 0.6L12WAP = 0. 6 litres + 12 weeks after planting; 1.2L12WAP = 1.2 litres + 12 weeks after planting; 0.6L16WAP = 0. 6 litres + 16 weeks after planting; 1.2L16WAP = 1.2 litres + 16 weeks after planting.

Table 3: Effect of the varying litres of irrigation water and harvesting stage on proximate composition of *B. decumbens*, *P. maximum* and *P. pennisetum*

Parameters (%)	Foragee	0.6L8WAP	1.2L8WAP	0.6L12WAP	1.2L12WAP	0.6L16WAP	1.2L16WAP	SEM
Dry matter	Brachiaria	50.70^{e}	49.33^{f}	56.50^{c}	53.05^{d}	65.49^{a}	63.54^{b}	0.91
	Panicum	56.46^{b}	52.01^{d}	57.42^{ab}	53.51^{c}	58.51^{a}	56.96^{b}	0.92
	Pennisetum	56.46^{b}	52.01^{d}	57.42^{b}	53.51^{c}	58.51^{ab}	59.96^{a}	0.26
Crude protein	Brachiaria	9.63^{b}	10.50^{a}	9.65^{b}	9.52^{b}	7.05^{d}	8.54^{c}	0.18
	Panicum	7.88^{d}	9.63^{c}	10.51^{a}	9.65^{b}	7.06^{e}	7.05^{e}	0.20
	Pennisetum	13.14^{b}	14.88^{a}	10.42^{e}	12.25^{c}	9.88^{f}	11.33^{d}	0.25
Crude fibre	Brachiaria	14.62^{f}	15.68^{e}	18.62^{c}	17.58^{d}	22.35^{a}	20.27^{b}	0.38
	Panicum	17.47^{f}	17.67^{e}	19.44^{c}	18.56^{d}	21.37^{a}	20.50^{b}	0.21
	Pennisetum	17.47^{f}	17.67^{e}	19.44^{c}	18.56^{d}	21.37^{a}	20.50^{b}	0.21
Ether extract	Brachiaria	2.12^{e}	2.09^{f}	3.48^{a}	3.34^{b}	2.19^{d}	3.23^{c}	0.09
	Panicum	5.63^{b}	5.48^{c}	3.92^{e}	4.04^{d}	3.89^{e}	5.82^{a}	0.12
	Pennisetum	3.32^{a}	3.28^{a}	2.12^{d}	2.08^{e}	2.08^{e}	3.29^{b}	0.09
Ash	Brachiaria	9.67^{a}	9.56^{c}	8.10^{f}	9.48^{d}	9.58^{b}	8.63^{e}	0.90
	Panicum	6.24^{e}	6.35^{d}	7.51^{a}	7.12^{c}	7.53^{a}	7.08^{b}	0.14
	Pennisetum	6.22^{e}	6.35^{d}	7.50^{a}	7.12^{c}	7.54^{a}	7.26^{b}	0.08
NFE	Brachiaria	14.67^{d}	11.49^{f}	16.66^{c}	12.14^{e}	24.34^{a}	20.89^{b}	1.23
	Panicum	16.25^{b}	12.89^{c}	16.05^{b}	16.76^{b}	18.68^{a}	13.73^{c}	0.85
	Pennisetum	16.30^{b}	9.84^{d}	16.54^{b}	13.52^{c}	17.67^{a}	14.57^{c}	0.27

$^{a-f}$: Means in the same column with different superscripts differ significantly (P< 0.05); SEM: Standard error of means; Brachiaria = *B. decumbens*; Panicum = *P. maximum*; Pennisetum = *P. purpureum*; 0.6L8WAP = 0.6 litres + 8 weeks after planting; 1.2L8WAP = 1.2 litres + 8 weeks after planting; 0.6L12WAP = 0. 6 litres + 12 weeks after planting; 1.2L12WAP = 1.2 litres + 12 weeks after planting; 0.6L16WAP = 0. 6 litres + 16 weeks after planting; 1.2L16WAP = 1.2 litres + 16 weeks after planting; CP= Crude Protein (%); CF= Crude Fibre (%); EE= Ether Extract (%); DM= Dry Matter (%); NFE= Nitrogen Free Extract (%); ME= Metabolizable energy (Kcal/g).

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