

ASSESSMENT OF DROUGHT TOLERANCE LEVEL AND BIOMASS YIELD OF FOUR FORAGE GRASS SPECIES IN JALINGO, TARABA STATE, NIGERIA

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Received 18th May 2023 Accepted 15th August, 2023.

ABSTRACT

This study aimed at identifying suitable forage grass species that can adapt to Jalingo environmental condition in terms of biomass yield (fresh basis) and tolerance to short term drought condition. Four species of forage namely, Gamba grass (*Andropogon gayanus Kunth.*), Panicum maximum (Guinea grass), Ruzi grass (*Brachiaria ruziziensis.*), and Chloris gayana (*Chloris gayana.*) grass were evaluated. The seeds were procured from the National Animal Production Research Institute (NAPRI) Shika, Zaria in Kaduna State Nigeria. The species were planted in a 3 m x 4 m plot using a complete randomized design (CRD) with three replications. The seed were sown in a 30 cm spacing between plants by drilling at 3 cm depth. The total experimental area was 13 m × 26 m (338 m²) with an individual plot size of 12 m² and spacing between plots and replications of 1.5 and 2 m. Data were collected on days before germination, percentage germination, weekly growth rate, plant height (cm), leaves length (cm), leaves width (mm), number of leaves, tiller per stuff, tiller diameter (mm), Stuff diameter at 75 cm above soil level (cm), panicle length (cm) and drought tolerance (Percentages greenness). The data obtained were analyzed using analysis of variance. There was significant ($P<0.05$) variation in the number of days before germination with brachiaria ruziziensis. species germinate in an average of four days with 93.75% of the seed germination rate, while other species germinated in an average of six days after planting. Chloris gayana had a significantly tallest plant 99.0 cm while Gamba grass the longest leaf 36.5cm and highest number of tiller per stuff 51 tillers, while brachiaria had the highest number of leaves per plant and the highest fresh biomass yield 2800g/m². Gamba grass had a highest drought tolerance level of 57.9% greenness after 42 days of drought. Therefore, in terms of drought tolerance and highest number of tiller per stuff Gamba grass is recommended while in terms of fresh biomass yield and number of leaves brachiaria ruziziensis is the best.

Keywords: forage, grass, drought, species, adaption

INTRODUCTION

The grazing lands are gradually shrinking in size due to expansion of crop framing to satisfy the food needs of the increasing human population (Adeoye, 2017). Many perennial grasses are adapted to different agro-ecological zone of Nigeria. Precipitation and temperature patterns determine periods of growth and timing of hay, silage, or pasture utilization (Okwori and Abdulsalam, 2017). Forage grass

and pastures constitute the bedrock to sustainable livestock production system (Aliu *et al.*, 2020). When forages are grown as a crop, they have been found to produce high yields nutritive plant material suitable for livestock maintenance and production. Forage crops produce much yielding than natural forages and can be fed to cattle as both green forages during the rains or conserved for the long dry season (Anwar, 2019). Pasture-based production systems offer farmers and

ranchers the ability to let the ruminant's environment and immune system work together, thereby gaining an acceptable level of production while naturally maintaining the integrity of the ecological connections between ruminants, the soil and the pasture plants. Ruminants on pasture experience fewer health problems due partially to reduced stress, whereas ruminants that are subjected to confinement have their digestive physiology running at top speed (Rinehart, 2008). Several factors to consider in pasture and hay species selection fall into two broad categories: local adaptation and intended use (Marsalis *et al.*, 2020). Finding ways to improve forage availability and adaptability to Jalingo ecological condition is necessarily in order to trim down the drought vulnerability and encourage pasture based farmers to cultivate and sale to livestock farmers which may in turn reduced the conflict between herders and farmers. Therefore, this study aimed at identifying a suitable forage grass species that can adapt to Jalingo environmental condition in terms of biomass yield (fresh basis) and tolerance to short term drought condition

MATERIALS AND METHODS

Experimental Site

The study was conducted at an experimental field inside the milk collection center along Danbaba Suntai Airport Jauro Yunu Jalingo, Taraba State, Jalingo is located between 8.83° North and 11.22° East on Latitude 11.36' of the equator and possesses a tropical climate. The area is characterized by high temperature throughout the year, because of high radiation which is relatively evenly distributed throughout the year. Maximum temperature of about 40°C has been observed in the area with minimum temperature as low as 18°C between December and January, mean annual temperature ranges between 26.9°C and 27.8°C (Taraba State Diary 2010)

Sources of Experimental Materials

The seeds of the four different species of forage namely, Gamba grass (*Andropogon gayanus Kunth.*), Guinea grass (*Panicum maximum*), Ruzi grass (*Brachiaria ruziziensis.*), and Chloris gayana (*Chloris gayana kunth.*) were sourced from the National Animal Production Research Institute (NAPRI) Shika, Zaria in Kaduna State.

Seedbed Preparation and Experimental Design

The experimental plots were prepared after land clearing and leveling that were all done manually. Dried poultry manure was applied manually based on the standard rate of 15kg/ha for pasture field. The loamy textured soil was wet for seven days to ensure water saturation and breaking down clods and firms the seedbed for improved seed-to-soil contact at planting time.

The species were planted in a 3 m x 4 m plot using a complete randomized design (CRD) with three replications for each species. The seeds were sowed in a 30 cm spacing between plants by drilling at 3 cm depth. The total experimental area was 13 m × 26 m (338 m²) with an individual plot size of 12 m² and spacing between plots and replications of 1.5 and 2 m. The treatments were sown according to their recommended seeding rates. The amount of seeds for each species were determined by dividing the recommended seed mass by the pure live seed (the product of seed germination and purity) as described by Islam and Ashilenje, (2018). This experiment was carried during the dry season from the month of December 2022 to March, 2023.

Data Collection

Date of germination, Percentage germination, weekly growth rate and percentage greenness were measured.

Morphological Parameters Measurements

Forage growth rate were measured on weekly basis using a meter rule by randomly selecting ten (10) stands per plot starting from first week after germination to sixteen weeks as described by Mbahi *et al.*, (2016). The following morphological parameters were also measured: Plant height (cm), Leave length (cm), Leave width (mm), number of leaves, Tiller per stuff (unity), Tiller diameter (mm), Stuff diameter at 75 cm above soil level (cm) and Panicle length (cm).

Physiological Parameters

Drought Tolerance (Percentages greenness)

Drought tolerance was tested using percentage greenness. At seven (7) weeks after germination a plot was selected from each treatment (specie) and a total number of green leaves were counted from five randomly selected stands. The selected plots were deprived water and the number of

green leaves were counted on a weekly basis from week eight to week thirteen and the percentage of green leaves were calculated for each week in each plot as:

Percentage greenness

$$= \frac{\text{Total number of green leaves per week per plant}}{\text{The total number of green leaves before water deprivation}} \times 100$$

Biomass Yield (fresh basis) at Week Thirteen

A one-meter square wooden quadrat was randomly placed in each of the randomly selected field for each of the species. The fodder contained inside the quadrant was cut close to the ground and immediately wrapped inside a labeled plastic bags and weighed (fresh) as described by Zanella, et al.(2017). Total weight of fresh biomass yields from each species was recorded

Statistical Analysis

Data were analyzed for variance (Proc ANOVA) using the SAS software (Version 9.4),

Table 1: Number of Days before Germination of Four Species of Forage Grass Grown in Jalingo

Species	Panicum	Ruzi grass	Rhodes grass	Gamba grass	Std Error
Days Before Germination	6.00 ^a	4.00 ^b	6.00 ^a	6.00 ^a	0.261

Germination

Germination depends on quality of seedbed that will enable good contact between seed and soil. There was significant ($P < 0.05$) difference in germination percentage among the species. *Brachiaria ruziziensis* had 93.7% of sowed seed germinated while the other three species had similar germination percentage Table 2. In contrast to the present study, Okwori and Abdulsalam, (2017) reported a maximum of 63% emergence for *brachiaria*, 87% for *chloris gayana* and 53% for *andropogon gayanus* under different soil type in Nasarawa State, North Central, Nigeria. This difference may be attributed to

Table 2: Germination percentage (%) of Four Grass Species Grown in Jalingo

Species	Germination percentage (%)
Guinea grass	52.08±15.02 ^b
Ruzi grass	93.75±3.60 ^a
Rhodes grass	50.00±9.54 ^b
Gamba grass	62.50±12.50 ^{ab}

Means with the same letters in a column are not significantly different

Growth Performance

There was significant ($P < 0.05$) difference in plant height with *chloris gayana*

and the significant differences among the mean were tested using Tukey's test.

RESULTS AND DISCUSSION

There was significant ($P < 0.05$) difference in number of days before emergence after planting with *Brachiaria ruziziensis*. species germinating in an average of four days while other species germinate in an average of six days Table1. As in the present study, Roy et al, (2009) reported an average germination days for seeds of grass such as *Chloris gayana* to be 3-4 days. However, Ohmstedt and Mwendia, (2018) reported 10–28 days for germination of *Panicum* maximum planted in Kenya. The correct seeding method and date as well as planting depth and rate are important factors in forage establishment. Though, variation in number of days before germination may be associated with species difference, quality and age of seeds.

seeds quality, seed-to-soil contact which is of extreme importance when planting by any method. The seed must remain in contact with moist soil for proper germination. There are various methods for achieving seed-to-soil contact while planting. Drilling with a grass drill is the most effective, as it allows for better control of seed placement (Rinehart, 2008). Germination is also affected by crop species and the seed's dormancy, age, damage, weathering, and storage conditions. Seedling vigour might also be affected by the same factors as germination (Marsalis et al., 2020).

having tallest plant at 42 days after germination while gamba grass had the least height as shown in Table 3. Species' growth rate and habits are

key determinants of their compatibility and longevity (Islam and Ashilenje, 2018). Leaf length differed ($P<0.05$) with gamba grass having the longest length while bracharia grass recorded the least. Leaf width also differed ($P<0.05$) among the four species with guinea grass had the widest leaf while chloris gayana having the least. As in the present study, Okwori and Abdulsalam, (2017), reported that the soft but hairy leaves of bracharia has a length of up to 25 cm and 1.5 cm width. Similarly, tiller per stuff also differed significantly with andropogon gayanus having statistically the highest number tiller per stuff. Tillers of grasses arise from axillary buds present in the axis of lower leaves. As a result, tiller production per plant is controlled in part, by leaf production per plant, and by rhizome buds. Tiller production of grasses is also affected by nitrogen fertilization, especially in thin stands (Hernandez, 2000).

Tiller density is correlated with overall biomass production (yield) in grasses. Therefore, selection for increased tiller number per plant is an effective method for increasing biomass production and to obtain greater yields per grass. Therefore, when choosing the best forage crops for increase production and productivity, number of tillers is a crucial morphological factor to consider (Mijena and Getiso, 2023). The number of leaf per plant determine the photosynthetic capacity of the plants. There was significant ($P<0.05$) difference in the number of leaves per species with bracharia ruziensis grass recording the highest number of leaves per plant which may be attributed to the higher number of tillers per stuff in the specie. Yigzaw, (2019) also reported a highly significant variation in leaves number between different species of fodder grass due which was attributed to effect of harvesting stage.

Table 3: Growth Performance of Four Forage Grass Species Grown in Jalingo

Species	Guinea Grass (Panicum Max)	Ruzi Grass (Bracharia ruziensis)	Chloris Gayana(chloris gayana ruth)	Gamba Grass (Andropogon gayanus)
Morphologic Parameters				
Plant Height (cm)	53.4±3.78 ^b	33.9±2.35 ^c	99.0±4.48 ^a	20.1±1.16 ^d
Leaf Length (cm)	25.4±1.04 ^b	18.8±0.60 ^c	25.0±1.13 ^b	36.5±1.66 ^a
Leaf Width (cm)	2.52±0.55 ^a	1.24±0.03 ^b	0.79±0.02 ^b	1.14±0.04 ^b
Tiller per stuff	38.3±4.24 ^b	37.1±1.77 ^b	16.5±0.88 ^c	51.2±3.08 ^a
Stuff diameter at 75 cm above soil level (cm)	2.67±0.32 ^b	4.45±0.65 ^a	3.315±15.02 ^{ab}	0.00±00.00 ^b
Panicle length (cm)	10.93±1.23 ^a	00.00±000 ^b	11.05±1.02 ^a	00.0±00.0 ^b
Agronomic Parameter				
Number of Leaves	172±7.21 ^b	309±48.0 ^a	134±5.17 ^b	186±19.3 ^b

Means with the same letters in a row are not significantly different

Biomass Yield

There was no significant difference in fresh biomass yield among the four species though bracharia ruziensis specie had the highest yield compare to the other two species as presented in Table 4. This may be due to the fast growth rate of bracharia ruziensis with sufficient moisture in the soil that enhanced strong seedling

vigour, ease of establishment and the ability to suppress weeds under the tropical condition as observed by (Mutwedu *et al.*, 2020). It may also be as a result of bracharia ruziensis high number of tiller per stuff in the present study as tiller density was reported to positively correlate with overall biomass production (yield) in grasses (Hernandez, 2000).

Table4: Fresh Biomass Yield of Four Forage Grass Species Grown in Jalingo

Species	Biomass Yield gram/m ²
Panicum maximum	2000±000
Bracharia ruziensis.	2800±1200
Chloris gayana kunth.	2000±400
Andropogon gayanus Kunth.	2200±600

Drought Tolerance (Percentage Greenness)

Andropogon gayanus had the highest percentage greenness at 42 days of drought. As in the present study Ohmstedt and Mwendia, (2018) reported that brachiaria species had moderate tolerance to drought condition while panicum maximum (Tropical seeds) has good tolerance. Similarly, Andropogon gayanus Kunth. was reported to have the ability to withstand prolonged drought conditions and stays green well into the dry season. Grass Species establishment, productivity, persistence and resilience against climate change are important considerations for the suitability of species to particular environments (Islam and Ashilenje, 2018). Locally adapted forages will have less risk

and will establish more successfully. The choice of adapted varieties that are palatable to the animals you plan to graze and have the characteristics that match your planned timing and intensity of grazing is very essential in pasture establishment. However, water availability may limit the selection to drought-tolerant species (Hart et al., 2008). Species that cannot adapt to the site or to its intended use will fail even if all other requirements are met (Shewmaker and Bohle, 2010). Resilience and productivity are linked to plant species characteristics and interactions that enable them to recover from adverse conditions and compensate for the loss of susceptible species (Islam and Ashilenje, 2018).

Table 5: Percentage Greenness over a Period Drought of Four Forage Grass Species Grown in Jalingo

Species	Panicum maximum	Brachiaria ruziziensis.	Chloris gayana kunth.	Andropogon gayanus Kunth.
Percentage Greenness at				
7 days of drought	78.0±3.50 ^a	86.4±4.30 ^a	78.9±1.65 ^a	78.8±0.40 ^a
14 days of drought	71.6±6.15 ^a	76.9±6.80 ^a	77.0±9.35 ^a	76.3±17.8 ^a
21 days of drought	67.9±6.15 ^a	65.5±4.30 ^a	67.0±5.70 ^a	73.4±16.8 ^a
28 days of drought	61.5±5.15 ^a	57.1±3.40 ^a	59.2±4.40 ^a	69.5±16.7
35 days of drought	56.0±3.30 ^a	51.4±2.10 ^a	55.3±3.75 ^a	64.7±15.6 ^a
42 days of drought	49.6±2.30 ^a	46.8±2.00 ^a	49.8±4.65 ^a	57.9±14.5 ^a

Means with the same letters in a row are not significantly different

CONCLUSION

Brachiaria ruziziensis species has an average of four days (the least) germination period with 93.8% germination success in addition to the highest number of leaves per stand and the highest fresh biomass yield than other species. However, *Andropogon gayanus* Kunth., had the highest drought tolerance level of 57.9% greenness after 42 days 'of drought in addition to longest leaf length and highest number of tillers per stuff. Therefore, in terms of drought tolerance and highest number of tiller per stuff and best adaption *Andropogon gayanus* Kunth grass is recommended while in terms of fresh biomass yield and number of leaves per stand *brachiaria ruziziensis* is the best.

ACKNOWLEDGEMENTS

The authors would like to thank the Tertiary Education Trust Fund (TETFUND) for the grant/ the financial support of this study. The authors would also like to thank the Taraba State University Jalingo for facilitation for the grant and the necessary facilities for smooth implementation of the project.

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