Evaluation of Morphogenesis and Yield of Three *Pennisetum purpureum* Varieties in South-West, Nigeria

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Abstract
This experiment, conducted at the Federal University of Agriculture, Abeokuta, Nigeria evaluated the morphogenesis of three varieties of *Pennisetum purpureum* used in this study, which were the local, purple, and FI variety at different stages of growth. The plants were established through vegetative plant parts (stems) sourced from a previously established plot and planted using 1 m × 1 m spacing on plots measuring 4 m × 5 m. The plants were fertilized with split doses of poultry manure at 4 t/ha (equivalent to 120 kg N/ha). The experiment was laid out as a Randomized Complete Block Design. Data on the morphogenic traits and dry matter yield were collected at bi-weekly from the 4th week for a period of twelve weeks. Results showed that the morphogenic plant traits differed significantly ($p<0.05$) between the varieties, except the tiller appearance rate ($p>0.05$) which was not significantly ($p>0.05$) different when the varieties were compared. The purple variety had the least plant elongation and leaf appearance rate values, however, for both traits, the F1 hybrid and local variety had similar trait values. The F1 variety had the least ($p<0.05$) leaf elongation rate value and the highest leaf ($p<0.05$) expansion rate value. On the other hand, the local and purple variety had comparably higher leaf elongation rate and leaf expansion rate values. The purple variety had higher ($p<0.05$) dry matter yield at the 6th and 8th week, but at the 10th and 12th week, the local variety produced the highest dry matter yield. In conclusion, the varieties had distinct morphogenic traits. Also, while the purple variety produced higher dry matter yield at the early stages of growth, dry matter production was higher for the local variety at more advanced stages of growth (10 and 12 weeks).

Introduction
In Tropical Africa, low productivity levels plagues the profitability of ruminant animal production sector, owing to the fact that majority of the ruminant animals in the tropics depend on forages sourced from the natural pasture which is constrained by seasonal fluctuations that places a limitation on the availability of year-round high quality forages (Ojo et al. 2014). The narrative is worsened in the dry season, where the available forages on natural pasture are in limited amounts and are unable to meet minimal animal nutrient requirements (Babayemi and Bamikole 2006).

Plausible solutions are embedded in the deliberate cultivation and management of forage crops, such that the intended ruminant forage consumption target can be measured against the forage production volume and needed land area for cultivation. Also, the selection of high yielding, quality, persistent, and perennial forages through proper management would ensure the supply of forages for livestock consumption which is a sustainable practice (Ojo et al. 2014). *Pennisetum purpureum* is a high yielding forage grass that is well adapted to the tropical climate and several genetic improvements have been made to the grass, and some varieties have over the years, emerged as part of a conscious breeding effort to raise the yield of the grass (Maleko et al. 2019). The evaluation of these varieties through a comparison of their growth traits that influence their yield is quintessential for the selection of candidate varieties that would be recommended for production. For this reason, this study evaluated the morphogenesis and yield of three *P. purpureum* varieties grown under similar environmental conditions.

Methods and Study Site

The experiment was carried out at Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. The three varieties of *P. purpureum* used in this study were the local, purple, and FI variety. The grasses were planted using vegetative stem cuttings measuring 30 cm in length with at least 2 nodes above the ground in July, 2019. The stem cuttings were planted on plots measuring 4 m × 5 m with a spacing of 1m between and within rows. Analysis of the physico-chemical properties of the soil, revealed the soil contained 0.09 % total nitrogen, 0.78 % organic carbon and 1.43 mg/kg phosphorus. Because of the low N content of the soil, 4 t/ha of dried poultry manure (equivalent to 120 kg N/ha) was applied to all plots in split dosage. A first fertilizer dosage was applied 2 weeks before planting and another dosage at 3 weeks after planting. The experiment was laid out as a Randomized Complete Block Design with the three varieties considered as factors. the varieties were replicated four times per block for a total of 6 blocks. The morphogenic traits of the plants were measured in a destructive bi-weekly sequence for a total of 12 weeks, with the first data collected at 4 weeks after planting. A destructive measurement was used because, the dry matter yield of the grasses were also measured bi-weekly and was done immediately after the bio-morphogenic traits were measured. The morphogenic traits and dry matter yield were recorded on eight randomly selected (replicates) on each block per variety. The initial and final recorded values for plant height (cm), leaf length (cm), leaf width (cm), number of leaves, and number of tillers were to estimate the plant elongation rate, leaf elongation rate, leaf expansion rate, leaf appearance rate, and tiller appearance rate respectively. At the end of the bi-weekly measurement, plants on a plot per block was sampled using a 1m × 1m quadrat, and plants within the quadrat were harvested at 5 cm above ground level and weighed to determine the fresh weight. After fresh weight determination, sub-samples weighing approximately 500 grams from each plot were dried at 65 ^oC until constant weight, and dry matter percentage was calculated using the weight difference method. The dry mater yield was calculated by multiplying the dry matter percentage value with the fresh weight value, following which we extrapolated the dry matter yield values to tonnes per hectare. Data collected were analysed using a two-way analysis of variance (variety and block effects), and where there were significant differences between the varieties, the Tukey HSD was used to separate the means.

Results

The morphogenic plant traits differed significantly ($p<0.05$) between the varieties, except the tiller appearance rate which was similar ($p>0.05$) when the varieties were compared (Figure 1). The purple variety had the least plant elongation and leaf appearance rate values. For both traits, the F1 hybrid and local variety had similar trait values; however, the F1 variety had the least leaf elongation rate value and the highest leaf expansion rate value. On the other hand, the local and purple variety had comparable higher leaf elongation rate and leaf expansion rate values. The purple variety had significantly ($p<0.05$) higher dry matter yield at the 6th and 8th week, but at the 10th and 12th week, the local variety produced the highest dry matter yield.

Discussion

The three varieties studies although have an erect growth habit, there were still inherent differences in their morphological trait values. The observed preference for plant elongation, leaf elongation or leaf expansion reveals the mechanism the plants used to capture sufficient light for photosynthesis. In the F1 hybrid variety, investments in plant elongation, leaf expansion, and leaf appearance were preferred over leaf elongation. This plant investment pattern has been linked to an adaptive feature that enables increased light capture under low sunlight conditions (Guenni et al. 2008). The mechanism was however, different for the local variety, which favoured investments in plant and leaf elongation, and leaf appearance over leaf expansion. According to literature, this permits a better distribution of light inside the canopy, and prevents etiolation of the lower leaves (Gomide et al. 2011). The purple grass variety on the other hand only favoured investments in leaf elongation over the other morphogenic traits. This mechanism may be a conservation strategy which favours the production of lesser leaves as its coping mechanism against rapid moisture loss (Paciullo 2011, 2016). However, the differences in the trait values observed for the varieties revealed that the morphogenic traits of the varieties is determined by their genetics rather than the environment, since they all grown under the same environmental condition.

There was no consistent variation in the dry matter yield values of the plants across the week of growth except the local variety which produced fairly consistent higher yields from the 10th to the 12th week. However, dry matter 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 (Paciullo 2011 and Liu et al. 2019). Therefore, the differences in the dry matter yield obtained for the three varieties depends upon investment patters at a particular stage of growth and the various biotic and abiotic filters that influence their development. It is also noteworthy to point out that the better yield traits recorded for the local variety at the latter stages of growth, may be due to the fact that it is better adapted to the environment that the other varieties, or perhaps it prioritize the growth of existing tillers than investments in new tillers.

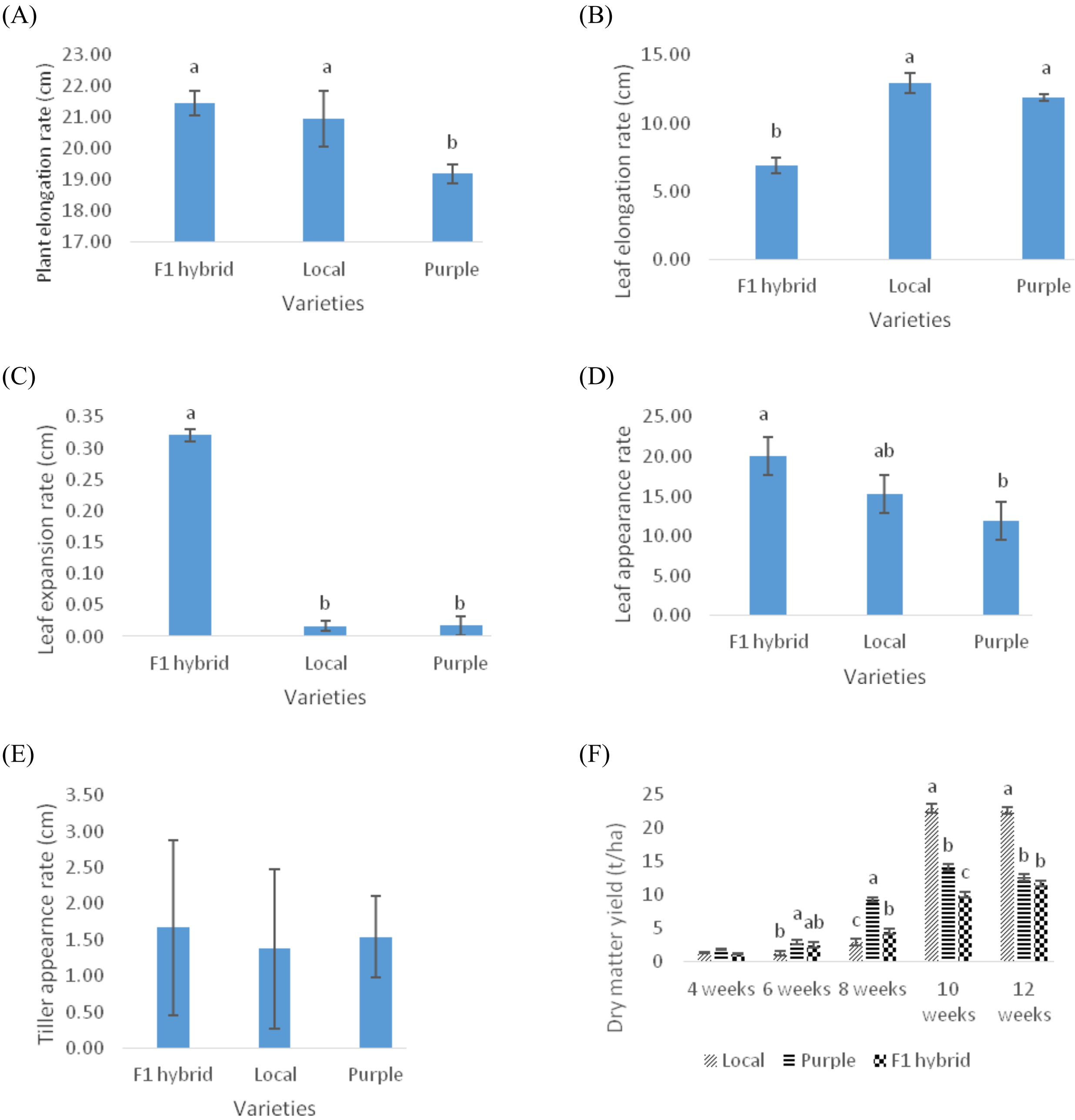

Figure 1: Morphogenic traits and dry matter yield of three *Pennisetum purpureum* varieties

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