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Adaptability and Forage Productivity of *Panicum phragmitoides* Stapf. in the Southern Region

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ABSTRACT

Background: Adaptability and forage productivity of *Panicum phragmitoïdes* in the humid region of Côte d'Ivoire were evaluated compared to *Panicum maximum* cv C1 from October 2018 to April 2019.

Methods: Three accessions of *P. phragmitoïdes* and *P. maximum* cv C1 were transplanted by cuttings with three replicates in a randomized complete blocks design to evaluate adaptability parameters and forage yield.

Result: The average number of tallies per tuft of *P. phragmitoïdes* ranged from 15.83±2.24 to 19.17±7.39 versus 33.67±5.10 tallies for *P. maximum* cv C1. Accessions of *P. phragmitoïdes* ranged in height from 146.33±9.49 to 151.42±15.88 cm and were higher than *P. maximum* cv C1 which was 119.50±20.67 cm. The forage productivity of *P. phragmitoïdes* and *P. maximum* cv C1. were identical and ranged from 4.84±1.07 to 8.20±3.72 t DM/ha/year. *P. phragmitoïdes* seems to adapt well in the humid region of Côte d'Ivoire.

Key words: Adaptability, Humid region, *Panicum maximum* cv C1, *Panicum phragmitoïdes*.

INTRODUCTION

Panicum maximum cv C1 is a productive fodder grass (34 t DM/ha/year) resistant to bushfire (Noirot *et al*., 1986), well palatable by cattle and resistant to grazing and trampling (César, 2005; Sana, 2015). It has fine foliage and is particularly adapted to the Sudanian zone (César, 2005). Although it is a species widely popularized in Côte d'Ivoire, it is a self-shattering species (Mandret and Noirot, 1999). That induces low grain productivity, with poor quality seeds, in direct harvesting, whether manual or mechanical (Mandret and Noirot, 1999; César, 2005). In addition, the selling cost of the produced seed is high (Noirot, 1990). Then, the high cost of this variety of seed is considered the main obstacle to its popularization (Noirot, 1990). In fact, forage plants propagated by seeds, if not too expensive, are favored by breeders (Vlavonou, 2009), as seed production is always more expensive than forage production, as demonstrated by Govind *et al*. (2016), with *Cajanus cajan*, a forage legume.

At the same time, among the collection of perennial *Panicum* species, *Panicum phragmitoides* Stapf (De Wouw *et al*., 2008), a forage species is quoted as well grazed in drier climates, is found in the Guinean and Sudanese Guineans humid savannahs (Poilecot, 1999). César and Coulibaly (1993) rank it in class 2 of pastoral value, *i.e*. in the class of species having either average production, limited palatability depending on the season and variable resistance to grazing or having low production with high food value. There is not a lot of documentation devoted to this species, in particular concerning its agronomic and zoo technical characteristics, except the work of Boudet (1975) for which, 40-days-old regrowths in the rainy season recorded a value in DNM of 43 g/kg DM and in UF/kg of 0.60. Recurring undocumented observations report that this species would keep its mature seeds on the panicles a little longer. If true, this information would offer the possibility of direct seed harvesting, with abundant and quality seed production. On the over side, seed production is justified if the agronomic and zootechnical parameters are encouraging. In fact, the choice of a forage species by the breeders is generally guided by the ease of implantation, productivity and plant adaptability (Mitja and Pascale, 2004). The present trial aims to study some characteristics of the *Panicum phragmitoides*, particularly its settlement parameters, its growth (tiller and height) and its fodder yield, in comparison with *Panicum maximum* cv C1.

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MATERIALS AND METHODS

Area of study

The experiment was conducted in Bingerville, a town located 20 km from Abidjan (Fig 1). The climate is of tropical monsoon type, with four seasons. The main rainy season, from April to July, is followed by a short dry season from August to September. Then followed the October to November short rainy season and finally the long dry season, from December to March, with little rain sometimes. The average temperature was 26.4°C and the average annual precipitation was 1823 mm. The soils are ferralitic, highly desaturated and reworked, full of physical properties and cultural aptitudes favorable to their cultivation (Pep Engineering, 2015).

Obtaining biological material

Panicum maximum cv C1 and *Panicum phragmitoides* were used in this study.

Panicum maximum cv C1 was sampled at Yamoussoukro Seed Station, an Ivorian structure in charge of tropical fodder seeds production.

Panicum phragmitoides was collected in the center of Côte d'Ivoire, in the Gbêkê region, in three different areas, around Bouaké, the capital of this region. The village of Affouvassou, which coordinates 30 N 0275078 / UTM 086671; the second one on the Bouaké-Diabo axis, coordinates 30 N 0269950/ UTM 0854616 and the third locality is on the Bouaké-Brobo axis at the point 30 N 02850099 / UTM 0849359.

In the village of Affouvassou, tufts of *Panicum phragmitoides* were collected under shade, near a shoal, close to a backwater. The herbaceous layer was dominated by *Andropogon gayanus*. The soil was deep, sandy-gravelly and humus-rich at that place. On the Bouaké-Diabo axis, *Panicum phragmitoides* was collected along a paved road. The vegetation was made of a field of cashew trees, herbaceous plants: *Andropogon tectorum*, *Andropogon gayanus, Hyparrhenia dissoluta, Hyparrhenia rufa* and woody species such as *Pilostigma thonningii, Daniellia oliveri.* The soil was sandy clay. *Panicum phragmitoides* was harvested along the asphalt road on the Bouaké-Brobo axis. Besides the *Panicum phragmitoides*, the herbaceous vegetation was composed, of *Hyparrhenia subplumosa, Hyparrhenia dissoluta, Andropogon gayanus, Hyptis souavelens, Walteria indica*. Ligneous species were composed of *Daniellia oliveri, Pilostigma thonningii* and *Terminaria glossesens.* The soil was slightly clayey and sandy but non-humus.

Depending on the origin of the plant material, a codification was established (Table 1).

The plant, once harvested, was trimmed until getting tufts of 25 to 30 cm in length in order to facilitate the transport and increase its survival time. Then there was placed in a gauge at the Yamoussoukro Seed Station (SSY), in April 2018 for three months for vegetative propagation. At the end of the gauge, it was destumpped again and transported to the experimental site to start the test.

Soil preparation and experimental device

The experimental site was lightly tilled with a hoe followed by pulverization with a rake. The experimental apparatus was a totally randomized block with three repetitions. In each of the elementary pieces of 10 m^2 (5 m × 2 m), cuttings were planted in October 2018, the distance of 50 cm in all directions, *i.e.* 55 cuttings per elementary plot (Fig 2). The cutting was composed of roots with cut ends, the collar and a bouquet of 3 tiller leaves selected 15 cm above the tillering platform.

Measured parameters

During the first 60 days after trial establishment (establishment phase), the number of alive plants was recorded every 8 days; this allowed the recovery rate (RR) of the species to be calculated using formula 1:

$$\text{Recovery rate per tuff RR (\%)} = \frac{\text{Number of live plants}}{55} \times 100 \quad \ldots(1)$$

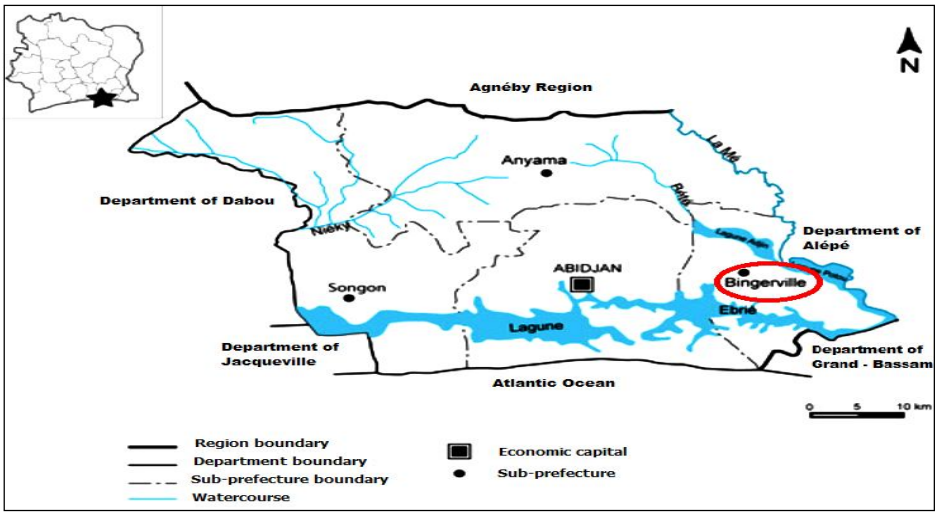


Fig 1: Bingerville in the District of Abidjan (Akou, 2010).

On four feet previously identified at random, 5 weeks after implantation the number of tillers per foot was observed and 6 weeks after establishment, the height of the plants was measured.

The tillering level was obtained by direct counting, after stump removal. Plant height was determined measuring the main tiller with a ruler, *i.e*. the tallest tiller, from the base to the top of the highest leaf or the inflorescence if any.

At the end of the establishment phase, an equalization cut was made at 15 cm from the ground early December 2018. In February 2019, at eight weeks of regrowth, the number of tillers per plant was again determined, as well as the height of the plants using the same methods as previously.

The potential forage yield was also assessed at the same period. In each elementary piece, square measuring 50 cm on a side was chosen at random for that.

The four feet included in the square were mowed 15 cm from the ground around 10 a.m., after the dew evaporated.

There were gathered into one bundle and weighed *in situ* using an electronic grocer's scale, CAMRY brand, with a precision of 1 g and a capacity of 5 kg. The fresh weight thus obtained per elementary plot is noted (Fw).

For a given accession, the different biomasses from each repetition were added, chopped manually into short strands of about 5 cm, then homogenized.

Three 100 g aliquot samples, weighed using the same balance, were collected. There were packaged in plastic bags and put to an oven at 70°C for 72 hours to obtain dry weights (Dw).

The dry matter rate (DMR) was then calculated by formula 2:

$$\text{Dry matter rate (DMR) (\%)} = \frac{DW \times 100}{100} \quad ....(2)$$

Where

Dw= Dry weight of the aliquot sample.

The average dry matter rate (DMRa) per accession was obtained by formula 3:

$$\text{DMRa (\%)} = \frac{DMR1 + DMR2 + DMR3}{3} \quad ....(3)$$

Where

DMR1= Dry matter rate of repetition 1.

DMR2= Dry matter rate of repetition 2.

DMR3= Dry matter rate of repetition 3.

Fodder productivity per m^2 (g DM/m^2/year) per elementary plot was calculated using formula 4:

$$\text{Fodder productivity/m}^2\ (\text{Fw m}^2)\ (\text{g DM/m}^2\text{/year}) = \frac{4 \times (DMRa \times Fw)}{100} \quad ....(4)$$

Where

Fw= Fresh weight obtained per repetition over an area of 0.25 m^2.

The forage yield (FY) in tons of dry matter per hectar per elementary piece was obtained by formula 5.

$$\text{Forage yield (FY)} \left(\frac{\frac{tMS}{ha}}{an}\right) = \frac{10000 \times Fwa}{10000} \quad ....(5)$$

Where

Fwa= Average fresh weight obtained per repetition over an area of 0.25 m^2.

Data analysis

In order to make a comparison of the different averages obtained, the normality of the samples as well as the homogeneity of the average variances were checked by respectively the Shapiro and Levene tests.

In the absence of normality or homogeneity of variances, the data were transformed into log (x+1).

The averages variances (recovery rate, tillering level, plant height and forage yield) were compared, using variance analysis (ANOVA) at a threshold factor of 5%.

The Newman-Keuls test was later used to separate the averages in case of significant difference. XLSTAT 2014.5.03 software was used for data processing.

RESULTS AND DISCUSSION

Setting-up parameters

Plant recovery rate

Both species recorded the same recovery rates (P>0.05), ranging between 52.12±2.78% and 67.88±16.89% (Fig 3). All accessions implantation recovery rates, 8 weeks after settlement, between 50% and 60%, are mean, according to the scale proposed by Koutouan (2014). In central Côte d'Ivoire, Amalaman (2009) obtained a recovery rate of 82.42% for *P. maximum* C1. This rate increased up to 89% with fertilization. The recovery rate is influenced by several factors such as choice of tillers, there preparation, absence of parasitic attacks and especially optimal water supply of the plant material (Bulgden and Dieng, 1997). For *Panicum maximum*, a rainfall of at least 1200 mm/year is necessary to allow the growth and development of this species (Adjolohoun *et al.,* 2008), because seed production is more expensive than forage production, even for pulses (Govind *et al*., 2016).

The plants included in this study having undergone the same treatments, recovery average rates recorded could be explained by lack of fertilization and especially by under water supply. In fact, the setting-up of the trial was late. It was done at the end of the short rainy season. The plants could not benefit from sufficient water for their growth and development. So, with *P. maximum* C1 reference, which recorded an average recovery rate compare to *P. phragmitoides*, but which presented good recovery rates in another locality, one could expect higher recovery rates for *P. phragmitoides* with non-defective strains, sufficient water supply and adequate fertilization.

The recovery rate is a very important parameter, because the ease of installation in order to limit weedings is a very important criterion for selection of a forage plant (Vlavonou, 2009).

Tillering level

The average number of tillers per tuft of *P. phragmitoides* accessions, five weeks after planting, varied non-significantly (P>0.05) between 15.83±7.43 and 19.17±8.00. This level of tillering was lower (P<0.05) than that of *P. maximum* cv C1, which was 33.67±14.00 per tuft (Fig 4). These results matched with the observations of Poilecot (1999), who had previously stated that the tillers of *Panicum phragmitoides* are large and rigid but less numerous. Those observations would be due to the fact that *Panicum phragmitoides,* during its growth, has a plagiotrope development. It orients itself in an oblique plane according to gravity. However, abundant tillering ensures better soil cover (Koutouan, 2014).

Plant height

Six weeks after seeding establishment, *P. phragmitoides* accessions showed similar heights (P>0.05), varying from 146.33±9.49 to 151.42±15.88 cm. These heights were however higher (P<0.05) than those of *Panicum maximum* cv C1, with 119.50±20.67 cm (Fig 5). Height of fodder plants during the setting-up is also an adaptability parameter. It makes it possible to assess the ability of forage plants to compete with other species for light (Koutouan, 2014). Within the *Andropogon* species, Koutouan (2014) observed a strong negative correlation between tuft height and tillering level. Amalaman (2009) observed that short forage species have higher level of tillering than tall species. The conclusions of those different authors seem to be confirmed through this study. The high height of *Panicum phragmitoides* added to its plagiotrope development suggest that in a spatial

Table 1: Origin of plant material.

N°	Forage species	Origin	Collection place	Identification code
1	*Panicum maximum* cv C1	Yamoussoukro autonomous district	Yamoussoukro seed station	PmC1
2	*Panicum phragmitoïdes*	Gbêkê area	Affouvassou village	PpA
3			Diabo crossroads	PpD
4			Brobo roads	PpB

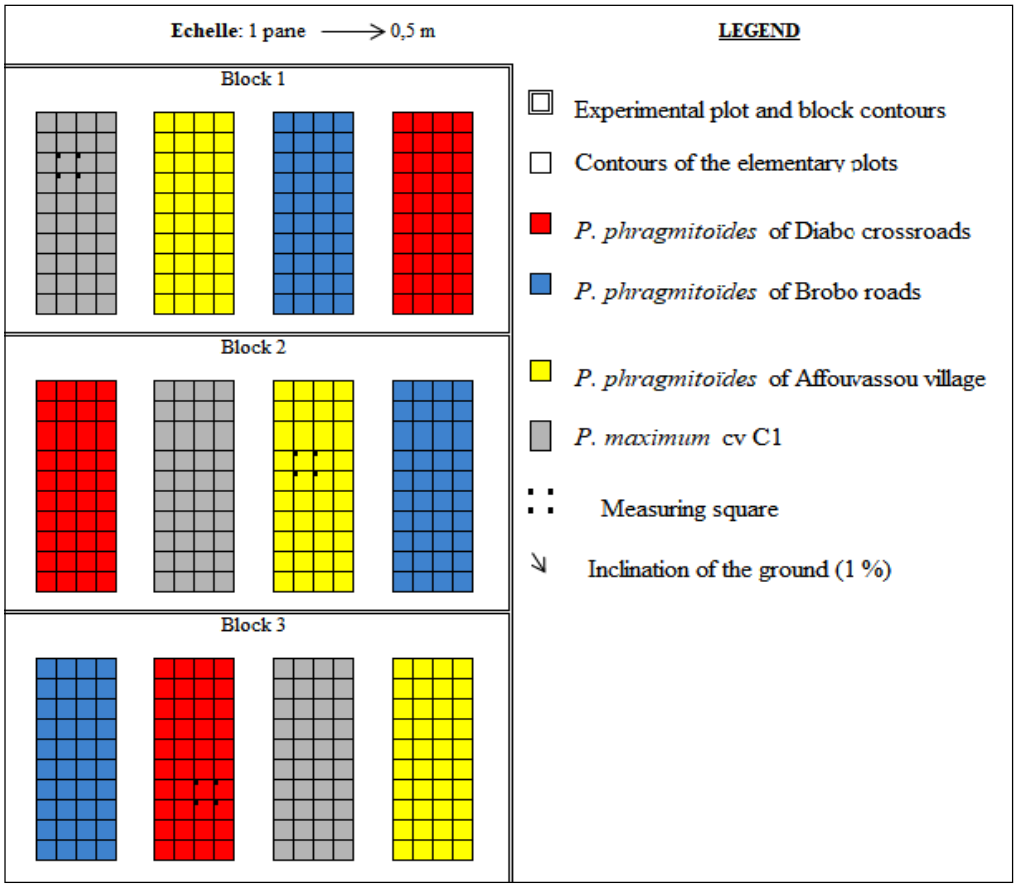


Fig 2: Experimental set-up.

competition, *Panicum phragmitoides* would let few possibilities for weed plants development. The establishment of *Panicum phragmitoides* would then require fewer weed control measures than what is currently in progress for *P. maximum* cv C1.

Operating parameters

Tillering level

Leveling cut which took place two months after the establishment of the species is a simulation of animal grazing. At eight weeks of regrowth, *P. phragmitoides* accessions mean number of tillers was the same (P>0.05). It varied from 28.08±6.30 to 31.50±17.56 tillers per tuft. However, this level of tillering was lower than that of *Panicum maximum* cv C1 (P<0.05) which was 71.08±22.40 (Fig 6).

However, abundant tillering ensures resistance to trampling, grazing and better soil cover. In addition, it ensures maximum fodder production and improves feed value (Koutouan, 2014). The obtained results suggest that *Panicum phragmitoides* would be less interesting than *Panicum maximum* cv C1 in terms of resistance to trampling, grazing, soil cover, forage productivity and food value.

Plant height

Both species have recorded the same average heights per tuft (P>0.05), ranging between 170.04±12.78 cm and 175.50±14.64 cm (Fig 7). That height, moreover, increased when moving from the establishment phase to the operation phase. Following the leveling cut, species studied reacted by growing higher, exceeding the level reached during the establishment phase. That means *P. phragmitoides* would tend to grow more when grazed. But, as reported by Koutouan (2014), this growth following grazing, should not be excessive, because it can be an obstacle of domestic ruminants grazing, especially cattles. In fact, there exploit the grass up to a maximum height of 2 m. Thus, the size reached by *P. phragmitoides* at 8 weeks of regrowth seems ideal for good use in pasture, provided that at this age the grass is still of good quality. Considering forage productivity, *Panicum maximum* cv C1 and *P. phragmitoides* have the same yield, although the tillering level of *Panicum maximum* cv C1 is higher than that of *P. phragmitoides*. Those results therefore does not confirm the previous assumption made above regarding the prediction of *P. phragmitoides* productivity compared

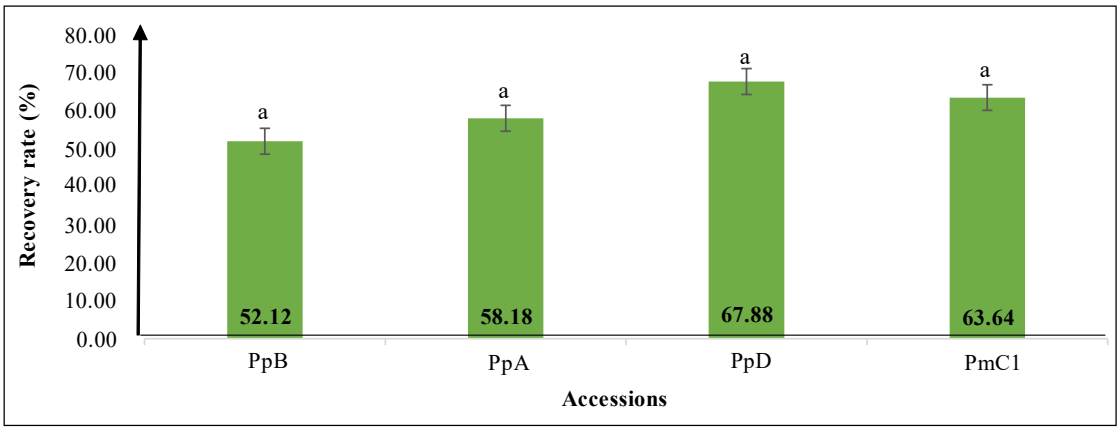


Fig 3: Recovery rate of the settlement of the different accessions.

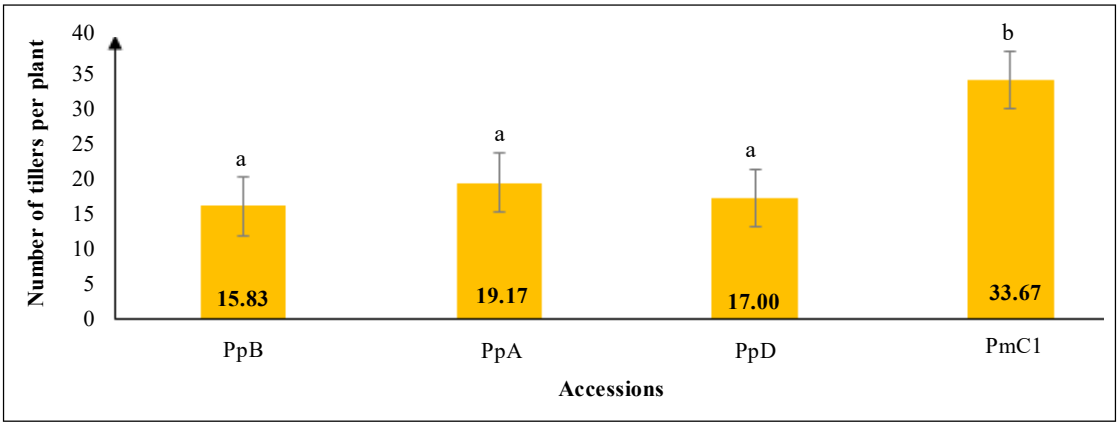


Fig 4: Number of tillers per plant 5 weeks after establishment.

to that of *P. maximum* cv C1, based on the level of tillering of each species. Thus, *P. phragmitoides* would have compensated this disadvantage by its taller height and the vigor of its tillers. Indeed, forage species that have both a high height and a large diameter also have a large biovolume (Adjolohoun *et al.*, 2012).

Fodder productivity

Fodder yields of both species didn't vary significantly (P>0.05) from 4.84±1.07 to 8.20±3.72 t DM/ha/year (Fig 8).

The yields obtained are comparable to the yields of 6 to 7.5 t DM/ha/year obtained in the Sudanian zone of Burkina Faso by Sana *et al.* (2020). There nevertheless remain low

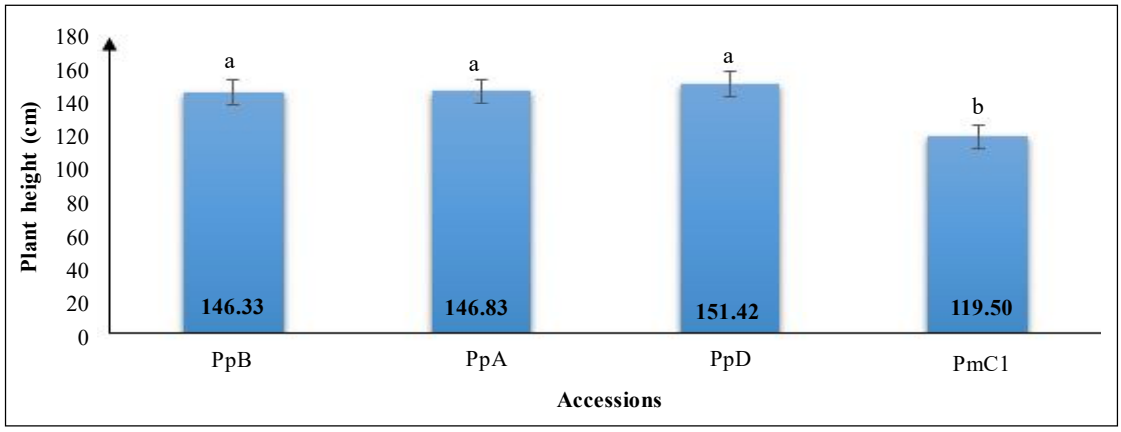


Fig 5: Plant height 6 weeks after establishment.

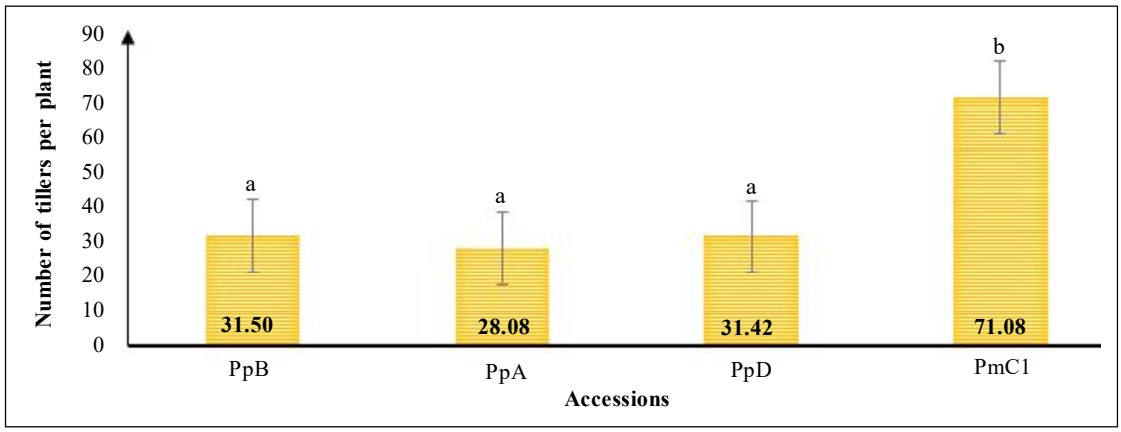


Fig 6: Number of tillers per plant at 8 weeks of regrowth.

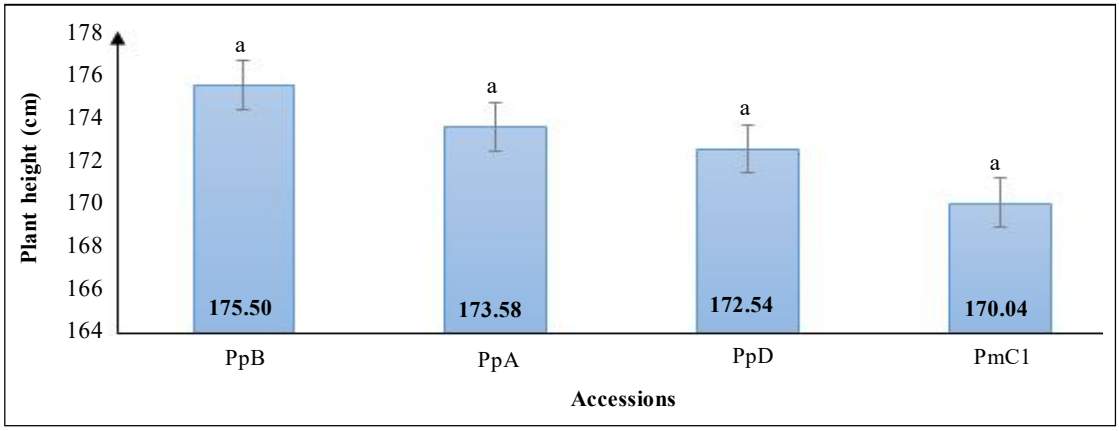


Fig 7: Plant height 8 weeks regrowth.

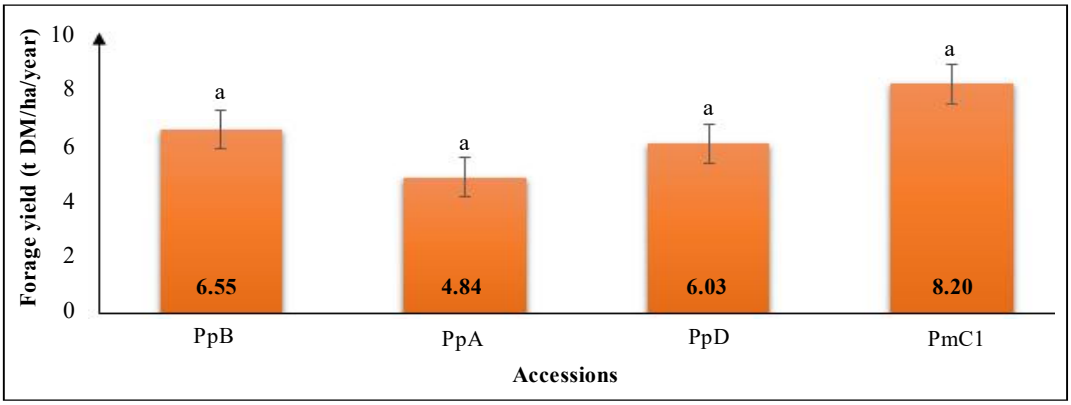


Fig 8: *P. phragmitoides* and *P. maximum* cv C1 forage yield.

compared to the 15 t DM/ha/year, reported by these same authors, obtained in the southern zone of Côte d'Ivoire, in rainfed and unfertilized crops and very low compared to 34 t DM/ha /year obtained by Noirot *et al.* (1986) in the same area, under irrigation and fertilization, reported by those same authors. Although *P. maximum* cv C1 is known to be adapted to the Guinean zone of Côte d'Ivoire and very productive in that space, it recorded low productivity. The results could be linked to the period of the trial setting up, during the short rainy season. It is therefore the dry season productivity that was evaluated. Refer to the productivity results previously obtained in *Panicum maximum* cv C1, one could therefore expect an improvement in the productivity of *P. phragmitoides* if it is fertilized and evaluated during the long rainy season.

CONCLUSION

After analysing the results obtained in *Panicum phragmitoides* in comparison with those of *P. maximum* cv C1, already known to be adapted to the Guinean zone of Côte d'Ivoire and very productive in the said area, we can conclude that *Panicum phragmitoides* would be adapted to the south zone of Côte d'Ivoire and very productive in this same space. However, a resumption of the trial under conditions of optimal water supply and under fertilization, will allow us to definitively assess the adaptability of this plant. Moreover, the resistance of *Panicum phragmitoides* to trampling and grazing, its ground cover and its food value should be studied. If the results are promising, the seed potential of this species should then also be evaluated.

Conflict of interest: None.

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