Differential vegetative and reproductive performances among fifteen guinea grass hybrids[1]

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Abstract – The main scope of this work was to detect (*Panicum maximum* Jacq.) genotype differences as to morphoagronomic and seed quality indices, and to establish character correlations useful for determining vegetative and reproductive trends. Besides the flowering cycle, eight phenological and two seed quality traits were scored in a greenhouse randomized complete block experiment, as follows: plant height (PH), reproductive tiller number/overall tiller number (RTN/OTN), panicle number/reproductive tillers (PN/RT), leaf length (LL), leaf width (LW), panicle length (PL), fresh weight (FW), dry weight (DW), number of seeds/g (NS/G) and seed sample physical purity (SPP). Very-early and early-flowering hybrids consistently showed the highest correlation values among flowering cycle and RTN/OTN (r = -0.59**), PN/RT (r = -0.48**), NS/G (r = -0.88**) and SPP (r = -0.80**) (reproductive parameters) while intermediate and late-flowering hybrids presented the highest values for LL (r = 0.53**), LW (r = 0.60**), PL (r = 0.77**), FW (r = 0.78**) and DW (r = 0.85**) (vegetative traits). The implications of these results for plant breeding and forage management purposes are discussed.

Index terms: *Panicum maximum*, flowering, agronomic characters, vegetative propagation.

Diferenças no desempenho vegetativo e reprodutivo entre quinze híbridos de capim-colonião

Resumo – O principal objetivo deste trabalho foi o de determinar as tendências de desempenho vegetativo e reprodutivo de híbridos de capim-colonião (*Panicum maximum* Jacq.) recém desenvolvidos, com os genótipos variando quanto ao ciclo de florescimento (desde muito precoces até tardios). Além do ciclo do florescimento, oito parâmetros fenológicos e dois de qualidade das sementes foram testados, em experimento em blocos completos ao acaso em casa de vegetação, como segue: altura da planta (AP), número de perfilhos reprodutivos/número total de perfilhos (NPR/NTP), número de panículas/perfilhos reprodutivos (NP/PR), comprimento da folha (CF), largura da folha (LF), comprimento da panícula (CP), peso fresco (PF), peso seco (PS), número de sementes/g (NS/G) e pureza física das amostras de sementes (PFS). Os híbridos precoces e semiprecoces apresentaram sempre os maiores valores de correlação obtidos entre ciclos de florescimento e NPR/NTP (r = -0,59**), NP/PR (r = -0,48**), NS/G (r = -0,88**) e PFS (r = -0,80**) (parâmetros reprodutivos) enquanto os híbridos intermediários e tardios apresentaram valores de correlação mais elevados de CF (r = 0,53**), LF (r = 0,60**), CP (r = 0,77**), PF (r = 0,78**) e PS (r = 0,85**) (características vegetativas). Discutem-se as implicações desses resultados para o melhoramento genético e o manejo de pastagens.

Termos para indexação: *Panicum maximum*, floração, características agronômicas, propagação vegetativa.

Introduction

Guinea grass (*Panicum maximum* Jacq.) is a warm-season perennial bunchgrass widely grown as a forage crop in tropical and warm-temperate regions of both hemispheres. Like most tropical grasses, it is a facultative apomictic species, where apospory and pseudogamy occur during the reproductive process.

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Due to the important role of guinea grass in the expansion of animal production, a number of research projects have been carried out on this species in recent years, covering a wide range of topics including: plant breeding (Sukhchain & Sidhu, 1991; Segui & Machado, 1992; Noirot, 1993; Sukhchain & Sidhu, 1993); cytology (Nakagawa et al., 1993; Hamoud et al., 1994; Naumova & Willemse, 1995); herbage yield and/or chemical composition (Hill et al., 1989; Santana, 1991; Bayorbor et al., 1992; Kawamoto et al., 1992; Segui et al., 1992; Singh et al., 1995); morphology (Costa et al., 1989; Alcantara et al., 1991); trampling resistance (Sun & Liddle, 1993); adaptation to acid soils (Thomas & Lapointe, 1989) among others.

Most of the above studies were performed under field conditions, not taking into account flowering cycle differences among cultivars/introductions, so making data comparisons difficult. In addition, none has been set up to evaluate vegetative and reproductive functions among genotypes widely variable for several traits.

The main scope of this research has been to detect genotype differences, as to morphoagronomic and seed quality indices and to establish character correlations, useful to determine vegetative and reproductive trends.

Material and Methods

Fifteen guinea grass hybrids derived from artificial crossings among previously selected highly sexual (female) and apomictic materials (male) were evaluated (Table 1). Seeds of each hybrid were sown in germination boxes, filled up with a mixture of topsoil, sand and organic matter (3:1:1 by volume). Fertilizer was added to soil according to soil analysis results. After four weeks, 30 individual seedlings per hybrid were transplanted to plastic bags (10 x 15 cm), filled up with the same soil mixture and placed in a greenhouse in a randomized complete block design with three replications (ten plants per replication).

During the experiment, all plastic bags were watered daily. At the onset of the flowering period, the number of days to flowering was scored for each individual plant. As the hybrids reached full blooming, the panicles were packed together in cloth bags (in the same treatment) to avoid seed shattering.

At harvest, the seeds were picked up from the bags and eight vegetative traits (plant height, reproductive tiller number/overall tiller number, panicle number/reproductive tiller, leaf length, leaf width, panicle length, whole plant fresh and dry weights) were scored in each treatment. Additionally, two seed quality tests (number of seeds/g and seed sample physical purity) were performed, according to International Seed Testing Association (1985). Plant height has been scored from soil surface to the panicle apex.

Measurement data (plant height, leaf length, leaf width, panicle length, fresh and dry weight) were used *per se* while countings (days-to-flowering, panicle number/reproductive tiller and number of seeds/g) and percentage data (reproductive tiller number/overall tiller number and seed sample physical purity) were transformed to $x^{0.5}$ and arc sin $(x/100)^{0.5}$, respectively, before statistical analysis.

An ANOVA computer program was used to test differences among hybrids and mean comparisons of different characteristics were made using Duncan's multiple range test. Finally, simple correlations were calculated among flowering cycles and all the quantitative traits studied.

Results and Discussion

The hybrids studied were ranked in four different groups, according to their flowering cycle: late, intermediate, early and very early-flowering types, using statistical analysis and/or consideration of

Table 1. Pedigree of the 15 guinea grass (*Panicum maximum* Jacq.) F_1 apomictic hybrids[(1)].

Hybrid	Female	Male
H-10	T_1SL	SEA-2
H-12	T_1SL	SEA-2
H-13	T_1SL	cv. Tobiatã
H-21	T_2SL	PI-277915
H-22	T_2SL	Hybrid-30
H-31	T_2SL	Guineagrass "Dr. Schanks"
H-33	T_2SL	Guineagrass "Dr. Schanks"
H-38	T_2SL	cv. Aruana
H-42	T_2SL	cv. Aruana
H-54	T_2SL	cv. Centauro
H-55	T_2SL	K-68
H-56	T_2SL	K-68
H-64	C_1SL	Hybrid-30
H-79	C_2SL	K-68
H-140	C_7SL	cv. Aruana

[(1)]SEA: South East African; PI: Plant Introduction; T_1SL: Tobiatã-1 sexual line; T_2SL: Tobiatã-2 sexual line; C_1SL: Centauro-1 sexual line; C_2SL: Centauro-2 sexual line; C_7SL: Centauro-7 sexual line.

other forage traits. Five of them (H-12, H-21, H-32, H-54 and H-64) were classified as late-flowering, five as intermediate-flowering (H-10, H-13, H-56, H-79 and H-55), three as early-flowering (H-140, H-22 and H-42) and two (H-31 and H-33) as very early-flowering types (Table 2).

Plant height varied from 2.5 m (H-56) to 3.4 m (H-54); reproductive tiller number/overall tiller number, from 26.3% (H-38) to 86.0% (H-22); panicle number/reproductive tiller, from 1.2 (H-64, H-56, H-79, H-55) to 3.4 (H-22); leaf length, from 34.7 cm (H-140) to 90.9 cm (H-64); leaf width, from 1.8 cm (H-22, H-140, H-31, H-33) to 3.5 cm (H-13); panicle length, from 20.1 cm (H-140) to 55.2 cm (H-64); fresh weight, from 392.4 g (H-140) to 1,184.6 g (H-64); dry weight, from 116.0 g (H-140) to 460.6 g (H-64). Seed quality indices scored were number of seeds/g, from 705 (H-21) to 1,288 (H-31) and seed sample physical purity, from 4.8% (H-54) to 87.2% (H-31).

The genetic materials used revealed wide genetic diversity for all the parameters studied under controlled greenhouse conditions, similar to that observed among cultivars/ecotypes of the same species in field trials (Costa et al., 1989; Alcantara et al., 1991; Segui et al., 1992; Sun & Liddle, 1993).

Significant high and positive simple correlations were obtained among flowering cycle and plant height (r = 0.524**); leaf length (r = 0.532**); leaf width (r = 0.609**); panicle length (r = 0.775**); fresh weight (r = 0.788**) and dry weight (r = 0.857**) (Table 3). Late and intermediate-flowering hybrids showed higher values for vegetative traits. On the other hand, highly significant negative correlations were observed among flowering cycle and reproductive tiller number/overall tiller number (r = -0.590**); panicle number/reproductive tiller (r = -0.484**); number of seeds/g (r = -0.881**) and seed sample physical purity (r = -0.807**). As a result, early and very early-flowering hybrids revealed a quite different performance.

Based on these results, the best strategy to preserve the variability within the species should take into consideration the flowering cycle of the available genetic materials. So, a rational and comprehensive germplasm bank should present several groups of ecotypes, introductions and cultivars with different

Table 2. Phenological and seed quality indices recorded on 15 guinea grass (*Panicum maximum* Jacq.) hybrids in a randomized complete block experiment[(1)].

Hybrid	FC Days	Ranking	PH (m)	RTN/OTN (%)	PN/RT	LL (cm)	LW (cm)	PL (cm)	FW (g)	DW (g)	NS/G	SPP (%)
H-12	215.7a	L	3.1bc	47.7efg	1.9cde	75.8cd	3.3ab	30.6cd	793.0b	341.7b	715h	16.9de
H-21	214.8a	L	3.1b	36.4gh	1.5ef	74.8d	3.4ab	36.1bc	838.8b	347.7b	705h	16.1def
H-38	214.3a	L	3.0bcd	26.3h	1.5def	74.0d	3.3b	27.6de	716.5bc	290.8bc	779g	12.0ef
H-54	205.4ab	L	3.4a	58.7cde	1.3f	90.4a	2.8c	49.9a	933.1b	343.0b	862ef	4.8f
H-64	198.2b	L	3.3a	58.1cdef	1.2f	90.9a	2.7cd	55.2a	1,184.6a	460.6a	838f	6.8ef
H-10	169.3c	I	3.1b	44.2efg	1.4f	81.9bc	2.3ef	40.7b	820.0b	335.3b	857ef	18.1de
H-13	139.4d	I	2.8de	67.5bc	1.9cd	66.4e	3.5a	41.5b	551.1cd	233.5cd	685h	30.0cd
H-56	137.7de	I	2.5f	44.3efg	1.2f	88.2ab	2.4ef	48.9a	541.2cd	218.2cde	948d	36.9bc
H-79	132.1ef	I	2.5f	43.3fg	1.2f	90.6a	2.2f	51.1a	786.1b	278.7bcd	918d	44.5bc
H-55	127.4fg	I	2.6f	51.3defg	1.2f	90.4a	2.5de	48.8a	702.0bc	198.8def	911de	41.4bc
H-140	123.4gh	E	2.6f	77.7ab	2.2bc	34.7f	1.8g	20.1f	392.4d	116.0f	1,044c	50.4b
H-22	118.4hi	E	2.9cde	86.0a	3.4a	35.3f	1.8g	24.6def	449.5d	127.6ef	1,006c	54.6b
H-42	115.2i	E	2.7ef	83.7a	2.5b	39.0f	1.9g	23.1ef	401.0d	138.0ef	1,133b	74.7a
H-31	91.2j	VE	3.0bcd	69.2bc	2.2bc	38.9f	1.8g	23.8ef	404.7d	136.7ef	1,288a	87.2a
H-33	89.8j	VE	3.0bc	65.4bcd	2.3b	40.7f	1.8g	24.0ef	410.0d	142.0ef	1,268a	85.6a
Mean	152.9		2.9	57.3	1.8	67.5	2.5	36.4	661.6	247.2	930.5	37.5
C.V.(%)	3.1		4.0	8.5	12.6	5.9	5.1	9.7	18.6	19.8	1.7	16.3

[(1)]Means, in the same column, followed by different letters are statistically different, according to Duncan's multiple range test, at $p<0.05$; CV: coefficient of variation; FC: flowering cycle (L: late; I: intermediate; E: early and VE: very early); PH: plant height; RTN/OTN: reproductive tiller number/overall tiller number; PN/RT: panicle number/reproductive tiller; LL: leaf length; LW: leaf width; PL: panicle length; FW: fresh weight; DW: dry weight; NS/G: number of seeds/g; SPP: seed sample physical purity.

Table 3. Simple correlation coefficients calculated among flowering cycle and eight phenological/two seed quality indices on 15 guinea grass (*Panicum maximum* Jacq.) hybrids[(1)].

Variable	PH (m)	RTN/OTN (%)	PN/RT	LL (cm)	LW (cm)	PL (cm)	FW (g)	DW (g)	NS/G	SPP (%)
FC (days)	0.524**	-0.590**	-0.484**	0.532**	0.609**	0.775**	0.788**	0.857**	-0.881**	-0.807**
t value	4.0	4.8	3.6	4.1	5.0	8.1	4.6	6.0	12.2	9.0

[(1)]FC: flowering cycle; PH: plant height; RTN/OTN: reproductive tiller number/overall tiller number; PN/RT: panicle number/reproductive tiller; LL: leaf length; LW: leaf width; PL: panicle length; FW: fresh weight; DW: dry weight; NS/G: number of seeds/g; SPP: seed sample physical purity. **Student t test significant at $p<0.01$.

flowering cycles. As a consequence, its maintenance and even the choice of genetic materials for breeding purposes would be easier. In this case, early stage-selection schemes would be feasible (for example, when the selection is aimed at short and narrow leaves, in a wide array of genotypes, the selected types, in most cases, will belong to the early or very early-flowering groups).

For forage management purposes, higher pasture persistence should be achieved by using early and very early-flowering hybrids, taking into account their higher seed yielding potentials (high reseeding rates in the field); however, due to their limited forage yields, lower stocking rates should be applied, as compared to those of intermediate and late-flowering cycle genotypes.

Conclusions

1. The genotypes used reveal wide diversity for all the parameters studied.

2. Significant high and positive simple correlations are obtained among flowering cycle and plant height, leaf length, leaf width, panicle length, fresh weight and dry weight.

3. Late and intermediate-flowering hybrids show higher values for vegetative traits; on the other hand, early and very early-flowering hybrids reveal a significant negative correlation with reproductive parameters.

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