DIFFERENTIAL ENERGY ALLOCATION AMONG 15 NEW GUINEAGRASS (PANICUM MAXIMUM JACQ.) HYBRIDS

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ABSTRACT
The main aim of this research work was to determine trends of energy allocation among newly developed guineagrass (*Panicum maximum* Jacq) hybrids, ranging from very-early to late-flowering genotypes. Besides the flowering cycle, eight phenological and two seed quality traits were scored in a greenhouse randomized complete block experiment including plant height (PH), reproductive tiller number/overall tiller number (RTN/OTN), panicle number/reproductive tiller (PN/RT), leaf length (LL), leaf width (LW), panicle length (PL), fresh weight (FW), dry weight (DW), number of seeds/gram (NS/G) and seed sample physical purity (SPP). Very-early and early-flowering hybrids consistently showed the highest correlations values between flowering cycle and RTN/OTN (r= - 0.59**), PN/RT (r= - 0.48**), NS/G (r= - 0.88**) and SPP (r= - 0.80**) (reproductive functions) while intermediate and late-flowering hybrids showed 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 functions). The implications of these results for plant breeding and forage management purposes are discussed.

KEYWORDS
Plant breeding, flowering cycles, morphological/agronomic parameters, character correlations

INTRODUCTION
Guineagrass (*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. Due to the important role of guineagrass in the expansion of animal production, a number of research projects have been conducted on this species in recent years, covering a wide range of topics including: plant breeding (Sukhchain and Sidhu, 1991; Segui and Machado, 1992; Noirot, 1993; Sukhchain and Sidhu, 1993), cytology (Nakagawa et al., 1993; Hamoud et al., 1994; Naumova and 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 and Liddle, 1993) and adaptation to acid soils (Thomas and Lapointe, 1989). Most of the above studies do not take into account flowering cycle differences among germplasm sources, making data comparisons difficult. Also, none was designed to consider different energy allocation trends among genotypes widely variable for specific characteristics, which is the main scope of this research.

MATERIALS AND METHODS
Fifteen guineagrass hybrids, derived from artificial crossings among previously selected highly sexual (female) and apomictic materials (male) were evaluated. Seeds of each hybrid were sown in germination boxes, filled up with a mixture of top soil, sand and organic matter (3:1:1 by volume). Fertilizer was added to soil according to analysis recommendations. 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 bagged together (in the same treatment) to avoid seed shattering. At seed harvest, eight vegetative traits (plant height, reproductive tiller number/overall tiller number, panicle number/reproductive tiller, leaf length, leaf width, panicle length, fresh and dry weight) and two seed quality parameters (number of seeds/gram and seed sample physical purity) were scored in each treatment. Measurement data (plant height, leaf length, leaf width, panicle length, fresh and dry weight) were used *per se* while counting (days-to-flowering, panicle number/reproductive tiller and number of seeds/gram) and percentage data (reproductive tiller number/overall tiller number and seed sample physical purity) were transformed to vx and arc sin vx/100, 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, single correlation coefficients 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 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 1). Plant height varied from 2.47 m (H-56) to 3.40 m (H-54); reproductive tiller number/overall tiller number, from 26.31% (H-38) to 85.99% (H-22); panicle number/reproductive tiller, from 1.21 (H-64) to 3.41 (H-22); leaf length, from 34.73 cm (H-140) to 90.90 cm (H-64); leaf width, from 1.77 cm (H-22) to 3.53 cm (H-13); panicle length, from 20.06 cm (H-140) to 55.23 cm (H-64); fresh weight, from 392.4 grams (H-140) to 1,184.6 grams (H-64); dry weight, from 116.0 grams (H-140) to 460.6 grams (H-64); number of seeds/gram, 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 under study, similar to that observed among cultivars/ecotypes of the same species (Costa et al., 1989; Alcantara et al., 1991; Segui et al., 1992; Sun and Liddle, 1993). High and positive simple correlations were calculated 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 2). Late- and intermediate-flowering hybrids allocated most of the produced energy to vegetative functions. On the other hand, highly significant negative correlations were observed among flowering cycle and reproductive tiller number/overall tiller number (r= - 0.592**); panicle number/reproductive tiller (r= - 0.484**); number of seeds/gram (r= - 0.881**) and seed sample physical purity (r= - 0.807**). As the result, early- and very early-flowering hybrids allocated most of their produced energy to reproductive functions. Based on these results, the best strategy to preserve the variability within the species should be strongly linked to the flowering cycle of the available genetic materials. These results also suggest potential parentals for future crossings and provide information on the development of early stage-selection schemes. Higher flexibility in forage management is possible by knowing the flowering cycle of the cultivars/ecotypes to be used. For example, early- and very early- flowering genotypes should be utilized in situations where higher stocking rates, shorter grazing and longer rest periods are desirable, because of their lower forage production and higher reseeding potential, as compared to those of intermediate- and late-flowering genotypes.

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Table 1

Phenological and seed quality parameters recorded on 15 new guineagrass (*Panicum maximum* Jacq) hybrids in a randomized complete block experiment.

HYBRID	FC[z] days	FC[z] ranking	PH (m)	RTN/OTN (%)	PN/RT	LL (cm)	LW (cm)	PL (cm)	FW (gram)	DW (gram)	NS/G	SPP (%)
H-12	215.7 a[y]	L	3.07 bc	47.67 efg	1.85 cde	75.83 cd	3.33 ab	30.57 cd	793.0 b	341,7 b	715 h	16.9 de
H-21	214.8 a	L	3.10 b	36.42 gh	1.46 ef	74.83 d	3.40 ab	36.07 bc	838.8 b	347.7 b	705 h	16.1 def
H-38	214.3 a	L	2.98 bcd	26.31 h	1.55 def	74.03 d	3.30 b	27.57 de	716.5 bc	290.8 bc	779 g	12.0 ef
H-54	205.4 ab	L	3.40 a	58.69 cde	1.29 f	90.43 a	2.77 c	49.90 a	933.1 b	343.0 b	862 ef	4.8 f
H-64	198.2 b	L	3.32 a	58.13 cdef	1.21 f	90.90 a	2.70 cd	55.23 a	1184.6 a	460.6 a	838 f	6.8 ef
H-10	169.3 c	I	3.11 b	44.24 efg	1.39 f	81.86 bc	2.33 ef	40.70 b	820.0 b	335.3 b	857 ef	18.1 de
H-13	139.4 d	I	2.80 de	67.47 bc	1.87 cd	66.40 e	3.53 a	41.53 b	551.1 cd	233.5 cd	685 h	30.0 cd
H-56	137.7 de	I	2.47 f	44.25 efg	1.17 f	88.20 ab	2.37 ef	48.90 a	541.2 cd	218.2 cde	948 d	36.9 bc
H-79	132.1 ef	I	2.52 f	43.27 fg	1.18 f	90.56 a	2.17 f	51.13 a	786.1 b	278.7 bcd	918 d	44.5 bc
H-55	127.4 fg	I	2.58 f	51.28 defg	1.17 f	90.43 a	2.50 de	48.80 a	702.0 bc	198.8 def	911 de	41.4 bc
H-140	123.4 gh	E	2.59 f	77.74 ab	2.24 bc	34.73 f	1.77 g	20.06 f	392.4 d	116.0 f	1044 c	50.4 b
H-22	118.4 hi	E	2.87 cde	85.99 a	3.41 a	35.27 f	1.77 g	24.57 def	449.5 d	127.6 ef	1006 c	54.6 b
H-42	115.2 i	E	2.67 ef	83.75 a	2.53 b	39.03 f	1.90 g	23.13 ef	401.0 d	138.0 ef	1133 b	74.7 a
H-31	91.2 j	VE	2.96 bcd	69.20 bc	2.22 bc	38.93 f	1.83 g	23.83 ef	404.7 d	136.7 ef	1288 a	87.2 a
H-33	89.8 j	VE	3.01 bc	65.43 bcd	2.32 b	40.67 f	1.80 g	24.03 ef	410.0 d	142.0 ef	1268 a	85.6 a
X[x]	152.86		2.89	57.32	1.79	67.47	2.49	36.40	661.6	247.2	930.46	37.52
CV(%)[x]	3.08		3.98	8.45	12.63	5.91	5.08	9.72	18.59	19.83	1.71	16.35

[x] X=overall character mean; CV=coefficient of variation (%);

[y] Means, in the same column, followed by different letters are statistically different, according to Duncan's multiple range test, at 5% probability level;

[z] FC=flowering cycle (L=late; I=intermediate; E=early and VE=very early); PH=plant height; RTN/OTN=reproductive tiller number/overall tiller number; N/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/gram and SPP=seed sample physical purity.

Table 2

Simple correlation coefficients calculated among flowering cycle and eight phenological/two seed quality parameters on 15new guineagrass (*Panicum maximum* Jacq.) hybrids.

	PH (m)	RTN/OTN (%)	PN/RT	LL (cm)	LW (cm)	PL (cm)	FW (gram)	DW (gram)	NS/G	SPP (%)
FC (days)[z]	0.524**	-0.590**	-0.484**	0.532**	0.609**	0.775**	0.788**	0.857**	-0.881**	-0.807**
t value	4.03	4.80	3.63	4.12	5.04	8.05	4.62	5.99	12.21	8.98

[z] 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/gram and SPP=seed sample physical purity;

** = Student t test significant at 1% probability level.