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HYBRID PROGENIES OF BAHIAGRASS: AGRONOMIC EVALUATION

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ABSTRACT - *Paspalum notatum* Flügge is one native forage grasses of southern Brazil. Through intraspecific hybridization, is possible generating progenies with variability for agronomic traits. The objective of this work was to evaluate 24 hybrids and select them for the superior agronomic traits, as well analyze correlations between forage traits that can assist in the selection of genotypes.The hybrids were obtained from crosses among sexual and apomictic clones, and were vegetative propagated in a greenhouse until the transplant to the field. The agronomic traits evaluated were: total green mass (TGM), leaf dry mass (LDM), stem dry mass (SDM), inflorescence dry mass (IDM), dead mass (DeM), total dry mass (TDM), growth habit (GH). Correlations between plant diameter (PD), number of tillers (NT), total dry matter (TDM), plant height (PH), total green matter (TGM), leaf dry matter (LDM), stem dry mass (SDM), number of inflorescences (NINF) and inflorescence dry matter (IDM) were performed using the Pearson correlation coefficient. The hybrids had great variability in all agronomic characteristics measured. Based on the three years of evaluation, hybrids KD9, KF1, KF4, and KD5 produced higher total dry mass than other genotypes. The hybrid KF4 too had greater LDM; KF1 and KF4 were the colder tolerant. These genotypes were selected for evaluations, such as seed production, fertilizer use efficiency, animal performance, and for new crosses. The high correlation of the total dry mass with the other forage components will be useful for indirect select criteria in bahiagrass improving strategies.
Keywords: *Paspalum notatum* Flügge, forage yield, intraspecific hybrids, plant breeding, traits correlation.

PROGÊNIES HÍBRIDAS DE GRAMA FORQUILHA: AVALIAÇÕES AGRONÔMICAS

RESUMO - *Paspalum notatum* Flügge é uma gramínea forrageira nativa do sul do Brasil. Hibridizações intraespecíficas geram progênies com variabilidade para características agronômicas. O objetivo deste trabalho foi avaliar 24 híbridos e selecioná-los pelas características agronômicas superiores, bem como analisar correlações entre características forrageiras que possam auxiliar na seleção de genótipos. Os híbridos foram obtidos através dos cruzamentos entre clones sexuais e apomíticos, e foram propagados vegetativamente em casa de vegetação até o transplante para o campo. As características agronômicas avaliadas foram: massa verde total (MVT), massa seca das folhas (MSF), massa seca do caule (MSC), massa seca da inflorescência (MSI), material morta (MM), massa seca total (MST), hábito de crescimento (HC). As correlações entre diâmetro da planta (DP), número de perfilhos (NP), massa seca total (MST), altura da planta (Alt), massa verde total (MVT), massa seca das folhas (MSF), massa seca do caule (MSC), número de inflorescências (NINFL) e massa seca das inflorescências (MSINFL) foram realizados utilizando o coeficiente de correlação de Pearson. Os híbridos tiveram grande variabilidade em todas as características medidas. Em três anos de avaliações, os híbridos KD9, KF1, KF4 e KD5 produziram maior MST; KF4 apresentou maior MSF; KF1 e KF4 foram os mais tolerantes ao frio. Esses genótipos foram selecionados para avaliações de produção de sementes, eficiência no uso de fertilizantes, desempenho animal e para novos ciclos de cruzamentos. A alta correlação da massa seca total com outros componentes da forragem será útil para critérios de seleção indireta em estratégias de melhoramento da grama forquilha.
Palavras-chave: *Paspalum notatum* Flügge, correlação de características, hibridização intraespecífica, melhoramento de plantas, produção de forragem.

INTRODUCTION

Paspalum notatum Flüggé, bahiagrass, is a perennial warm-season grass, dominant in the natural grasslands of Rio Grande do Sul state (Brazil), Uruguay and Argentina. The specie has a high productive potential and grazing tolerance, inferred by the presence of rhizomes that serve as a nutrient reserve, and high levels of intraspecific variability for breeding purposes (GRAMINHO et al., 2017).

The breeding program for this species aims to obtain, evaluate and select hybrid materials with superior agronomic traits, which can be registered and protected to be made available as a commercially available cultivar. The difficulty in breeding *P. notatum* species is largely due to the apomictic reproduction mode of genotypes, which limits genetic variability (WEILER et al., 2017). However, when sexual parents have the same ploidy level and number of chromosomes is expected a greater efficiency in the crosses (ACUÑA et al., 2019).

The crossing of tetraploid sexual plants, which have the reproductive phase induced by colchicine application, with native tetraploid ecotypes exhibiting

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apomictic traits, allows breeders to create and select superior hybrids which have their agronomic traits fixed through apomixes (WEILER et al., 2015). According to Acuña et al. (2019), the use of hybridization in apomictic plants relates to the possibility of releasing the natural diversity present in apomictic ecotypes and fixing superior F_1 hybrids. The superiority of apomictic hybrids is expected to be retained across reproductive cycles. Due a limited genetic basis of the apomictic hybrid varieties, new crosses cycles, adding selected sexual segregates from sexual × apomictic hybrid populations are needed in the breeding of tetraploid bahiagrass (MILES, 2007). Previous studies have agronomically evaluated *P. notatum* intraspecific hybrids and observed that the crosses provided large variability for traits such as forage production, cold tolerance and regrowth vigor (BARBOSA et al., 2019; WEILER et al., 2018; ZILLI et al., 2015).

The aim of this work was to evaluate and select intraspecific hybrids of *P. notatum* for superior agronomic traits, as well analyze correlations between forage traits that can assist in the selection of genotypes.

MATERIALS AND METHODS

Study site

The study was conducted at Eldorado do Sul, in the Depressão Central region (30º06'03''S and 51º41'28''W and altitude 34 m), Rio Grande do Sul state, Brazil. The climate is classified as subtropical humid (*Cfa*), which means the average minimum and maximum annual temperatures are 14°C and 24.2°C, respectively, with an average annual temperature of 19.6°C. The average annual rainfall is 1398 mm and the average annual relative humidity is 79% (BECKER et al., 2017). The soil is classified as typical dystrophic red argisol (ultisol). Prior to planting 1600 kg ha^{-1} of filler-type limestone (Relative Total Neutralizing Power = 100%) and 180 kg ha^{-1} of P_2O_5 (triple superphosphate) were applied and incorporated into the soil. Fertilizer applications were performed following the recommendations from Sociedade Brasileira de Ciência do Solo (SBCS, 2016) for perennial warm-season grasses. A total of 200 kg ha^{-1} of K_2O (potassium chloride) and 380 kg ha^{-1} of N (ammonium sulfate) were fractionally applied during the experiment.

Parent material, genotypes and crosses

The female parents were five sexual tetraploids genotypes: WKS63 and WKS92, artificial polyploids, 2n=4x=40 (WEILER et al., 2015) and the intraspecific hybrids D25, D16 and B2, selected for their superior agronomic traits (WEILER et al., 2018). As male parents, the apomictic tetraploid accession called Bagual, a native ecotype from Rio Grande do Sul state, Brazil, the plant WKS3, artificial polyploids, 2n=4x=40 (WEILER et al., 2015), and the genotypes D3 and C2, intraspecific hybrids selected for their superior agronomic traits (WEILER et al., 2018). Artificial crosses were performed in the greenhouse following the methodology used and described by Machado et al. (2021).

From the crosses, 24 hybrids were obtained, corresponding to five families. These were allocated the names: KC1 (WKS63 x Bagual), KD1, KD2, KD5, KD6, KD7, KD9 (WKS92 x Bagual), KE1 (D25 x Bagual), KF1, KF2, KF3, KF4, KF6, KF7, KF8, KF9, KF10, KF15, KF16, KF17 (D16 x D3), KN2, KN3, KN4, KN5 (B2 x C2). The hybrids (individual genotypes) were vegetative propagated in a greenhouse, generating four clonal replicates for each genotype, placed in 2.8-L pots with a commercial substrate until the transplant to the field.

As expected, the hybridization between sexual tetraploid and apomictic plants results in plants that segregated for reproduction mode. The mode of reproduction of the hybrids evaluated in this study was previously identified by Krycki et al. (2020).

Agronomic evaluations

In spring 2016, 24 hybrids plus the ecotype ‘Bagual’, the commercially available *P. notatum* cv. ‘Pensacola’ (used as Control), female parents and plants WKS63, WKS92 and WKS3 were transplanted to the 168 m^2 field site at the Experimental Agronomic Station of UFRGS, Brazil. The genotypes were established as individual plants, spaced 1 m x 1 m, with four replications in a completely randomized design. The experiment ran from spring of 2016 to autumn of 2019 (three years/growth seasons). Four cuts were performed in the first year: 02/24/2016 and 03/23/2016 (summer), 05/04/2016 (autumn), 11/25/2016 9 (spring); six in the second year: 01/04/2016, 02/08/2017 and 03/15/2017 (summer), 06/09/2017 (winter), 10/24/2017 and 11/28/2017 (spring) and two in the third: 01/16/2018 and 03/06/2018 (summer), totaling 12 cuts in the experimental period. The value of cuts was added and the average was calculated per cut/year.

Data analysis

The agronomic traits evaluated in this study were: total green mass (TGM, g plant^{-1}), leaf dry mass (LDM, g plant^{-1}), stem dry mass (SDM, g plant^{-1}), inflorescence dry mass (IDM, g plant^{-1}), dead mass (DeM, g plant^{-1}), total dry mass (TDM, g plant^{-1} = LDM + SDM + IDM + DeM), growth habit (GH = erect, prostrate and semi-erect) (WEILER et al., 2018).

Prior to cutting the number of tillers (NT plant^{-1}), plant height (PH, cm plant^{-1}) from the soil surface to the average leaf height and plant diameter were measured. During the winter months, visual assessments were made for cold tolerance, using a scale of 1 to 5, where 1 represents the plant with little damage (most cold resistant) and 5 the plants with severe damage (least cold resistant). A plant survival evaluation was carried out after winter, where the most vigorous plants received a score of 1 and the least vigorous received a score of 5.

After non-destructive observations each plant was cut to a residual height of 5 cm. Harvests were made at ~30-day intervals. Due to different growth habit, plants with erect growth habit were harvested when the average height reached 30-35 cm, while plants with prostrate growth habit were harvested at 20 cm (BARBOSA et al., 2019; WEILER et al., 2018).

Samples were weighed to obtain the herbage fresh weight and then separated into leaf blades, stems + sheaths, inflorescences and dead material. After separating the morphological components, samples were dried at 60°C in a forced-air oven for 72 h and then weighed.

The TDM, LDM and PD were analyzed using linear models on R statistical software (R CORE TEAM, 2019). Analysis of variance (ANOVA) was performed and, when significant differences among genotypes were detected, a means cluster was performed using the Scott-Knott test, to find distinct homogeneous groups of those means. All differences are reported at the α<0.05 level of significance. Correlations between PD, NT, TDM, PH, TGM, LDM, SDM, NINF and IDM were performed using the Pearson product-moment correlation coefficient. Results are described as "high" correlations where coefficients are between 0.80 to 1.0 and "intermediate" correlations where coefficients are between 0.50 to 0.80 (WEILER et al., 2018).

RESULTS AND DISCUSSION

Total DM yield differed ($p < 0.05$) among genotypes in Years 2 and 3 (Table 1). The Year 2 generated two groups, with the hybrids KC1, KD5, KD9, KF4, KF17, and KN2, as well as the ecotypes Bagual and WKS63 and the commercial cv. Pensacola that showed the greatest TDM yields (average 603.6 g plant^{-1}). In Year 3, greater variability was recorded, generated fours groups. Only four hybrid genotypes remained in the group with the highest TDM yields, KD5, KD9, KF1, and KF4, beyond the ecotype WKS63 (average 862 g plant^{-1}) (Table 1).

TABLE 1 - Total dry matter of 24 *Paspalum notatum* hybrids, their parents and a commercially available cultivar over three years.

Paspalum notatum hybrids	Total dry matter (g plant^{-1})			
	Year 1	Year 2	Year 3	Mean
KD5	147.3B*	798.1aA	791.9aA	579.1
KD9	82.6C	591.4aB	901.4aA	525.1
WKS63	59.3C	568.4aB	914.8aA	514.2
Bagual	112.1B	723.3aA	672.6bA	502.7
KF1	45.8B	268.3bB	1081aA	465.1
KF4	72.5B	547.0aA	727.2aA	448.9
KC1	131.9B	538.6aA	664.9bA	445.1
KF17	60.8B	573.6aA	674.5bA	436.3
KN2	161.4B	448.3aA	536.0bA	381.9
KF6	185.0B	373.0bA	532.2bA	363.4
Pensacola	39.1B	488.4aA	545.2bA	357.6
KN4	126.6B	379.0bA	537.4bA	347.7
KE1	112.0B	368.9bA	522.4bA	334.4
KF10	165.2B	322.8bB	499.7bA	329.3
KF9	102.5B	334.5bA	507.5bA	314.8
KN3	40.4C	315.6bB	559.7bA	305.2
KD2	58.4B	380.0bA	312.1cA	250.2
KF16	86.2B	227.3bB	414.3cA	242.6
KF3	36.1B	273.6bA	386.6cA	232.1
KD6	104.3A	276.7bA	271.2cA	217.4
KN5	81.9A	263.0bA	290.6cA	211.9
KF15	187.8A	186.7bA	239.3cA	204.6
WKS92	44.1B	235.2bA	330.6cA	203.3
KF8	68.0A	206.4bA	295.6cA	190.0
KF7	112.5A	174.8bA	140.6dA	142.6
KF2	36.1A	225.4bA	127.1dA	129.5
KD7	148.1A	137.1bA	51.9dA	112.4
KD1	113.1A	83.2bA	91.8dA	96.0
WKS3	6.45A	141.8bA	119.5dA	89.3
Mean	97.4	383.6	499.5	
CV(%)		19.9		

*Means followed by the same lower-case letters within each columns or capital letters within the rows do not differ significantly by the Scott-Knott test (p<0.05). CV = coefficient of variation.

Greater variability ($p < 0.05$) among genotypes was observed in the third year of evaluation. This can be attributed to the expression of genes present in adult perennial plants, from the second year following establishment. In the first year the plants are establishing and adapting to the environment. According to Pereira et al.

(2015), in the year of establishment young plants may only express some of the genes responsible for productive traits. Following establishment (Year 2) plants enter the adult phase and the entire genetic potential of the plant can be expressed, which can result in changes in the phenotype.

Importantly, four hybrids (KD5, KD9, KF1, and KF4) showed TDM yield higher than the commercial cv. Pensacola in Year 3, which indicates potential improvements in yield could be made. In perennial plants, the persistence of production is a fundamental trait for the selection of new genotypes since it represents the production capacity of the plants over time. Other studies have also reported higher TDM yields for hybrids of *P. notatum* compared to cv. Pensacola (BARBOSA et al., 2019; WEILER et al., 2018), which indicates that the hybridization technique, in addition to providing greater variability within the species, provides genotypes that are more productive than the current commercialized cultivar.

Leaf DM also varied genotypes in Years 2 and 3 (Table 2). In Year 2, hybrids KD5, KD9, KF4, KF17, and ecotype Bagual had the highest LDM yields. In Year 3, were generate five groups and only the hybrid KF4 had a superior LDM yield when compared to the other genotypes. Most genotypes showed the highest LDM yields in Years 2 and 3; however, ten genotypes showed the highest LDM yields only in the third year of cultivation. Our results showed the existence of several hybrids with higher LDM yield than cv. Pensacola over the years of evaluation. Moreover, it was observed that hybrid KF4, in addition to showing high yield of TDM, also had higher yield of LDM, being superior to cv. Pensacola and ecotype Bagual, which is recognized for its high leaf yield in a subtropical environment (MACHADO et al., 2019; STEINER et al., 2017).

Forage breeding programs have focused on the selection of genotypes with a higher leaf/stem ratio or percentage of leaves, since the leaf is the component with the highest nutritional value and most consumed by ruminants. The proportion of leaf material previously been shown to affect the feeding behavior of grazing cattle (FERNANDES et al., 2014).

TABLE 2 - Leaf dry matter of *Paspalum notatum* hybrids and their parents evaluated for three years.

Paspalum notatum hybrids	Leaf dry matter (g plant^{-1})			
	Year 1	Year 2	Year 3	Mean
KF4	58.43C*	417.9aB	607.7aA	361.3
KF17	45.93B	420.8aA	502.6bA	323.1
KD9	51.60C	357.5aB	518.9bA	309.3
KN2	108.0B	311.6bA	410.0cA	276.5
KD5	63.90B	343.2aA	416.0cA	274.4
Bagual	56.88B	398.6aA	350.5cA	268.7
WKS63	27.43C	294.1bB	452.7bA	258.1
KF10	122.9C	242.5bB	392.5cA	252.6
KC1	63.33C	250.6bB	439.6bA	251.2
KN4	72.17C	263.2bB	390.8cA	242.1
KF6	115.7B	266.5bA	319.8cA	234.0
KE1	85.50B	253.7bA	352.1cA	230.4
KF9	68.88C	220.3cB	360.2cA	216.5
KN3	22.90C	196.6cB	339.4cA	186.3
KF1	35.33C	185.3cB	323.6cA	181.4
Pensacola	15.83B	245.5bA	268.3dA	176.6
KF16	62.05C	166.4cB	272.7dA	167.0
KF3	29.15B	200.4cA	268.8dA	166.1
KD2	33.93B	194.7cA	183.2dA	137.1
KF8	47.28B	133.4dA	199.9dA	126.9
KN5	42.23B	157.4cA	179.3dA	126.3
KF15	108.83A	106.7dA	125.0eA	113.4
KD6	48.48A	135.6dA	116.0eA	100.0
KF2	32.43B	170.0cA	97.52eB	100.0
WKS92	25.88B	115.1dA	151.4eA	97.40
KF7	71.33A	114.3dA	87.31eA	91.03
KD7	87.90A	74.12dA	26.97eA	63.01
KD1	66.75A	43.99dA	52.11eA	54.33
WKS3	5.80A	71.11dA	62.63eA	46.52
Mean	58.1	224.4	290.4	
CV(%)		20.2		

*Means followed by the same lower-case letters within each columns or capital letters within the rows do not differ significantly by the Scott-Knott test (p<0.05). CV = coefficient of variation.

Plant diameter (PD) varied among genotypes during the three years of evaluation (Table 3). Plant diameters ranged from a minimum of 16.1 (KF2) to a maximum of 38.8cm (KD9) in Year 1. In Year 2, hybrids KD5, and KD9, the ecotype Bagual and cv. Pensacola had the greatest plant diameter, ranging from 79.6 to 88.9 cm. In Year 3, greater variability was recorded. Five groups were formed and the greatest plant diameter were observed for hybrids KD5, KD9, and KF17, well as for ecotypes Bagual, WKS63 and cv. Pensacola, ranging from 88.8 to 107.2 cm. Most genotypes showed the greatest PD in the third year of evaluation, except for KD7, KF7, and KF15.

The greatest difference in PD among the genotypes evaluated occurred from the second year, and indicates a marked variability in growth habit. Plant diameter is a trait that must be evaluated within breeding programs, as it represents capacity of the plant to cover the soil. Therefore, genotype selection with this trait, together with higher forage yield, can make novel cultivars available to be established in degraded areas or those showing initial signs of soil erosion and optimize livestock production systems in subtropical regions (JAURENA et al., 2021).

TABLE 3 - Plant diameter of *Paspalum notatum* hybrids and their parents evaluated for three years.

Paspalum notatum hybrids	Plant diameter (cm)			
	Year 1	Year 2	Year 3	Mean
KD9	36.8aC*	85.6aB	107.2aA	76.5
KD5	37.9aC	77.0aB	101.7aA	72.2
Bagual	37.7aC	75.8aB	95.2aA	69.6
Pensacola	30.5aC	79.6aB	93.7aA	67.9
WKS63	26.8bC	68.6bB	97.0aA	64.1
KC1	38.0aC	67.4bB	86.3bA	63.9
KF17	26.0bC	64.4bB	88.8aA	59.7
KF4	26.8bC	60.3bB	84.4bA	57.1
KE1	31.0aC	57.5cB	80.2bA	56.2
KN4	32.7aC	55.9cB	78.2bA	55.6
KD6	36.8aC	57.4cB	72.5bA	55.5
KN2	33.5aC	51.3cB	81.0bA	55.3
KF6	39.7aB	45.5cB	79.3bA	54.8
KD2	24.8bC	61.7bB	76.6bA	54.4
KF9	27.9bC	52.7cB	81.5bA	54.0
WKS3	24.5bC	57.4cB	77.3bA	53.1
KF10	35.8aC	48.1cB	74.7bA	52.8
KN3	19.6bC	53.3cB	83.7bA	52.2
KF16	31.2aC	50.1cB	74.3bA	51.8
KN5	25.4bC	50.9cB	74.1bA	50.1
WKS92	23.8bC	54.1cB	72.0bA	50.0
KF15	34.8aB	46.0cA	65.5cA	48.8
KF1	19.5bC	40.1dB	73.5bA	44.4
KF7	32.3aB	45.5cA	53.3dA	43.7
KF3	19.9bC	42.5dB	68.1cA	43.5
KD7	33.6aA	46.5cA	42.5eA	40.9
KF8	18.8bC	37.3dB	57.8cA	37.9
KD1	31.0aB	31.7dB	43.4eA	35.4
KF2	16.1bC	33.3dB	54.4dA	34.6
Mean	30.5	57.3	78.3	
CV(%)		9.56		

*Means followed by the same lower-case letters within each columns or capital letters within the rows do not differ significantly by the Scott-Knott test ($p<0.05$). CV = coefficient of variation.

In the evaluations of growth habit, 18 genotypes had an erect habit (Bagual, KD1, KD5, KE1, KF1, KF2, KF3, KF4, KF7, KF8, KF9, KF10, KF15, KF17, KN2, KN3, KN5, and WKS92), four genotypes had a semi-erect habit (KC1, KD2, KF16 and WKS63), and seven genotypes had a prostate habit (KD6, KD7, KD9, KF6, KN4, WKS3, and Pensacola). Among the six most productive hybrids in the third year of evaluation, three were classified as erect (KD5, KF4 and KF1) and one classified as prostrate (KD9). Weiler et al. (2018) reported erect types may require careful management because erect plants invest less in reserve structures, such as aboveground stolons, which may influence their survival under high grazing intensity. Acuña et al. (2009) found the most successful forage grasses in

Florida exhibited prostrate growth habits and persistence under grazing. These plants have the capability to spread and colonize new areas quickly.

The genotypes evaluated had moderate cold tolerance (scores 2 and 3), with 30 genotypes showing a score 3 and four genotypes (KF1, KF4, KF17 and KN3) had a score of 2. Cold tolerance and survival following winter presented low variability between genotypes. Subsequent winter survival score was intermediate, with score 2 for KC1, and score 3 for the other plants evaluated. In a study with *P. notatum* hybrids, Weiler et al. (2018) reported similar results for the cold tolerance trait; however, the authors observed high variability for the trait of survival following winter.

As expected, correlation analysis showed TDM and TGM were highly correlated, with r = 0.90, and plant DM was similar among genotypes (Table 4). There was a high correlation between TDM and LDM (r = 0.85). The NT trait was intermediately correlated with PD (r = 0.71), TGM (r = 0.71), TDM (r = 0.66) and LDM (r = 0.63) traits.

TABLE 4 - Correlation by Pearson's coefficient between forage traits of *Paspalum notatum* hybrids.

Traits	PD	NT	LDM	PH	TGM	TDM	SDM	NINF
PD								
NT	0.71*							
LDM	0.56*	0.63*						
PH	0.23*	0.37*	0.52*					
TGM	0.64*	0.70*	0.78*	0.52*				
TDM	0.56*	0.66*	0.85*	0.53*	0.90*			
SDM	0.38*	0.51*	0.51*	0.43*	0.80*	0.84*		
NINF	0.38*	0.45*	0.37*	0.32*	0.65*	0.68*	0.79*	
IDM	0.29*	0.39*	0.36*	0.30*	0.59*	0.72*	0.72*	0.70*

Plant diameter (PD), number of tillers (NT), total dry matter (TDM), plant height (PH), total green matter (TGM), leaf dry matter (LDM), stem dry mass (SDM), number of inflorescences (NINF), inflorescence dry matter (IDM). *Significant values at 5% probability.

The high correlations observed in the present study between the TGM and TDM traits and LDM trait, suggest that it is not necessary to separate the morphological components of plants (leaf, stem and inflorescences) from bahiagrass. Similar results have been described by other studies that evaluated hybrids of *P. notatum* (BARBOSA et al., 2019; WEILER et al., 2018) and hybrids of *P. plicatulum* Michx x *P. guenoarum* Arechav (MOTTA et al., 2016). Total dry matter is a trait of easier selection and measurement and indirectly select leaf production, identifying superior genotypes with agility and economy in the selection of forage species (PEREIRA et al., 2017). Our findings suggest a decrease in labor and evaluation times is possible when correlation studies are applied to a large number of genotypes within the breeding program.

According to Motta et al. (2016), the NT trait represents the capacity a plant has to create dense soil coverage, and thus reduce potential weed invasion. Intermediary correlation of the NT trait with PD, TGM and TDM traits suggests that when genotypes with the greatest forage yield are selected, genotypes with the greatest capacity for covering the soil will also be selected. The selected hybrids are indicated for new steps of assessments. The sexual plants with superior traits will be used as parents in new cycles of crossings and backcrosses within the breeding program. Hybrids with superior traits and that reproduce through apomixis have potential to be new cultivars with the possibility of registration and varietal protection with the Ministry of Agriculture, Livestock and Supply (MAPA). The release of new bahiagrass cultivars with high productive potential could widen the use of this important forage species, increasing the animal production per unit area and reducing the need to increase area.

CONCLUSIONS

We concluded that the hybrids KF1, KF4, KD9, and KD5 produced higher TDM than other genotypes and the hybrid KF4 had greater LDM than all genotypes.

The hybrids KF1 and KF4 were the colder tolerant.

These genotypes were selected for new evaluations, such as seed production, fertilizer use efficiency, animal performance and for new crosses.

The high correlation of the total dry mass with the other forage components will be useful for indirect select criteria in bahiagrass improving strategies.

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REFERENCES

ACUÑA, C.A.; MARTÍNEZ, E.J.; ZILLI, A.L.; BRUGNOLI, E.A.; ESPINOZA, F.; MARCÓN, F.; URBANI, M.H.; QUARIN, C.L. Reproductive systems in *Paspalum*: relevance for germplasm collection and conservation, breeding techniques, and adoption of released cultivars. **Frontiers in Plant Science**, v.10, [s.n.], p.1-17, 2019.

ACUÑA, C.A.; BLOUNT, A.R.; QUESENBERRY, K.H.; KENWORTHY, K.E.; HANNA, W.W. Bahiagrass tetraploid germplasm: reproductive and agronomic characterization of segregating progeny. **Crop Science**, v.49, [s.n.], p.581-588, 2009.

BECKER, E.L.S.; BURIOL, G.A.; STRECK, N.A. Clima e distribuição dos solos zonais no Rio Grande do Sul - Brasil, **Revista Geografar**, v.12, n.1, p.112-129, 2017.

BARBOSA, M.R.; MOTTA, E.A.M.; MACHADO, J.M.; KRYCKI, K.C.; CONTERATO, I.F.; WEILER, R.L.; DALL'AGNOL, M.; SIMIONI, C. Herbage accumulation of bahiagrass hybrids in two different environments in southern Brazil. **Pesquisa Agropecuária Gaúcha**, v.25, n.1/2, p.58-69, 2019.

FERNANDES, F.D.; RAMOS, A.K.B.; JANK, L.; CARVALHO, M.A.; MARTHA JUNIOR, G.B.; BRAGA, G.J. Forage yield and nutritive value of *Panicum maximum* genotypes in the Brazilian savanna. **Scientia Agricola**, v.71, n.1, p.23-29, 2014.

GRAMINHO, L.A.; DALL'AGNOL, M.; POTER, L.; LOPES, R.; SIMIONI, C.; WEILER, R.L. Forage characters of different *Paspalum* species in Rio Grande do Sul: a meta-analysis. **Ciência Rural**, v.47, n.7, e20161049, 2017.

JAURENA, M.; DURANTE, M.; DEVINCENZI, T.; SAVIAN, J.V.; BENDERSKY, D.; MOOJEN, F.G.; PEREIRA, M.; SOCA, P.; QUADROS, F.L.F.; PIZZIO, R.; NABINGER, C.; CARVALHO, P.C.F.; LATTANZI, F.A. Native grasslands at the core: a new paradigm of intensification for the Campos of Southern South America to increase economic and environmental sustainability. **Frontiers in Sustainable Food Systems**, v.5, e547834, 2021.

KRYCKI, K.C.; TEDESCO, M.; RODRIGUES, V.; WEILER, R.L.; BRUNES, A.P.; DALL'AGNOL, M.; SIMIONI, C. Reproductive analyses of intraspecific *Paspalum notatum* Flügge hybrids. **Crop Breeding and Applied Biotechnology**, v.20, n.1, e291620114, 2020.

MACHADO, J.M.; KRYCKI, K.C.; WEILER, R.L.; SIMIONI, C.; DALL'AGNOL, M. Reproduction mode and apospory expressivity of selected hybrids of *Paspalum notatum* Flügge. **Journal of Plant Breeding and Crop Science**, v.1, n.2, p.58-63, 2021.

MACHADO, J.M.; DALL'AGNOL, M.; MOTTA, E.A.M.; PEREIRA, E.A.; BARBOSA, M.R.; NEME, J.C.; KRYCKI, K.C. Productive potential of superior genotypes of *Paspalum notatum* Flügge in response to nitrogen fertilization. **Revista Brasileira de Saúde e Produção Animal**, v.20, p.1-13, e03102019, 2019.

MILES, J. W. Apomixis for cultivar development in tropical forage grasses. **Crop Science**, v.43, n.3, p.238-p.249, 2007.

MOTTA, E.A.M.; DALL'AGNOL, M.; NASCIMENTO, F.L.; PEREIRA, E.A.; MACHADO, J.M.; BARBOSA, M.R.; SIMIONI, C.; FERREIRA, P.B. Forage performance of hybrid *Paspalum* obtained from interspecific crosses. **Ciência Rural**, v.46, n.6, p.1025-1031, 2016.

PEREIRA, E.A.; DALL'AGNOL, M.; SARAIVA, K.M.; SIMIONI, C.; LEÃES, A.P.S.; SILVA, J.A.G. Genetic gain in apomictic species of the genus *Paspalum*. **Revista Ceres**, v.64, n.1, p.60-67, 2017.

PEREIRA, E.A.; DALL'AGNOL, M.; SCHNEIDER, R.; WEILER, R.L.; KUHN, N.J.I.S.; SIMIONI, C.; MAZURKIEVIC, G.; SILVA, J.A.G. Adaptabilidade e estabilidade em genótipos apomíticos do gênero *Paspalum*. **Ciência Rural**, v.45, n.8, p.1361-1367, 2015.

R CORE TEAM. **R:** A language and environment for statistical computing. Vienna: R Foundation for Statistical Computing, 2019. Available in: <http://www.R-project.org/>. Access in: 18 mar. 2021.

SBCS. SOCIEDADE BRASILEIRA DE CIÊNCIA DO SOLO. **Manual de calagem e adubação para os estados do Rio Grande do Sul e de Santa Catarina.** Porto Alegre: Comissão de Química e Fertilidade do Solo, 2016. 400p. Available in: <http://www.sbcs-nrs.org.br/docs/Manual_de_Calagem_e_Adubacao_para_os_Estados_do_RS_e_de_SC-016.pdf>. Access in: 15 nov. 2021.

STEINER, M.G.; DALL'AGNOL, M.; NABINGER, C.; SCHEFFER-BASSO, S.M.; WEILER, R.L.; SIMIONI, C., MOTTA, E.A.M. Forage potential of native ecotypes of *Paspalum notatum* and *P. guenoarum*. **Anais da Academia Brasileira de Ciências**, v.89, n.3, p.1753-1760, 2017.

WEILER, R.L.; DALL'AGNOL, M.; KRYCKI, K.C.; MACHADO, J.M.; MOTTA, E.A.M.; PEREIRA, E.A.; SIMIONI, C. Intraespecific tetraploid hybrids of *Paspalum notatum*: agronomic evaluation of segregation progeny. **Scientia Agricola**, v.75, n.1, p.36-42, 2018.

WEILER, R.L.; KRYCKI, K.C.; DAHMER, N.; GUERRA, D.; SIMIONI, C.; DALL'AGNOL, M. Determination of the mode of reproduction of bahiagrass hybrids using cytoembryological analysis and molecular markers. **Revista Brasileira de Zootecnia**, v.46, n.3, p.185-191, 2017.

WEILER, R.L.; KRYCKI, K.C.; GUERRA, D.; SIMIONI, C.; DALL'AGNOL, M. Chromosome doubling in *Paspalum notatum* var. *saure* (cultivar Pensacola). **Crop Breeding and Applied Biotechnology**, v.15, p.106-111, 2015.

ZILLI, A.L.; BRUGNOLI, E.A.; MARCÓN, F.; BILLA, M.B.; RIOS, E.F.; MARTÍNEZ, E.J.; ACUÑA, C.A. Heterosis and expressivity of apospory in tetraploid Bahiagrass hybrids. **Crop Science**, v.55, [s.n.], p.1189-1201, 2015.