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NOTE

Half-sib progenies evaluation in velvet grass

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ABSTRACT - *Velvet grass* (Holcus lanatus L.) *has a great potential use for winter pasture in subtropical regions due to its good establishment, persistence, high forage production, cold resistance, palatability and tillering ability. The objective of this work was to estimate genetic variability and heritability of agronomic traits and to identify superior progenies. Sixty half-sib progenies were assessed for natural height at the vegetative stage (NH), plant diameter (diameter), heading date (cycle), final height (after flowering) (FH), and tiller number (tillers). Difference among progenies was observed for all traits. Heritability estimates were 38%, 32%, 92%, 57% and 64% for NH, diameter, cycle, FH and tillers, respectively. The highest genetic gain estimate was 30.77 % for the tiller number. There is genetic variability for all the traits and gains after selection among half-sib progenies can be expected.*

Key words: Pasture, *Holcus lanatus*, additive variance, heritability, selection gain.

INTRODUCTION

Velvet grass (*Holcus lanatus* L.) is a grass from the temperate areas of Europe and Asia and from Canary Islands and currently it is widely distributed in temperate regions around the world (Watt 1978, Pitcher and Russo 2003).

It is a cold season, allogamic plant (Watt 1978), which in Brazil behaves as an annual or biannual (Araújo 1956, Oliveira et al. 2001, Pitcher and Russo 2003). It is a competitive species that tolerates a wide range of edaphoclimatic factors (Watt 1978). This species adapts mainly to humid lands (Klitsch 1965) and can survive during short periods of drought (Pitcher and Russo 2003), also being a species resistant to cold (Oliveira et al. 2001, Pitcher and Russo 2003).

Its adaptation to soil pH variation is wide, having as optimal pH conditions a range from 5.0 to 7.5 (Pitcher and Russo 2003). Velvet grass prefers soils with high organic matter content (Araújo 1956) and responds well to fertilization (Oliveira et al. 2001). The adaptation in poor soils and the high competitiveness of velvet grass are due to its radicular system, which is well developed and aggressive (Watt 1978).

It has been considered to be equivalent to Italian ryegrass at intermediary fertility conditions and moderate stocking rate (Rumball 1980). In Uruguay, it surmounts the Italian ryegrass in dry matter production in the critical periods of autumn, winter and the beginning of the spring season, with similar quality (Bemhaja 1993).

The species was introduced by the veterinarian Charles Vincent at Ponta Grossa, the State of Paraná, Brazil,

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in 1912. It adapted perfectly to the edaphoclimatic conditions of the State of Rio Grande do Sul, in which it was introduced in 1917 at the Posto Zootécnico de Viamão, where it started to disseminate to the rest of the State. Currently, it occurs spontaneously in pasture areas (Araújo 1956).

According to Oliveira et al. (2001), the species produces forage of intermediary quality; however, it has high palatability. Good acceptance of velvet grass forage by the cattle was described by Araújo (1956). In the experiments performed at the Embrapa Temperate Agriculture, velvet grass has shown a protein content equal to the tall fescue (*Festuca arundinacea*) and superior to *Bromus catharticus* (Gomes and Reis 2000).

Velvet grass has high tillering ability and produces forage earlier than other perennial temperate species (Araújo 1956, Oliveira et al. 2001). This grass evidenced a perfect adaptation to the environment and also a good productivity and may be used as pasture or hay (Araújo 1956). Other advantages of this species are the intense flowering and high seed production in the establishment year (Araújo 1956, Moraes et al. 2000). Besides the forage production, velvet grass might be used in soil erosion control and the recovery of soils with low fertility and acidity.

Due to all these traits, velvet grass is a very interesting winter pasture for regions with subtropical climate and, among the winter perennial grasses, the best adapted to Southern Brazil. However, there are no commercial varieties in the country and no seed is available for farmers.

The first step for the development of velvet grass varieties is to know the existing variability in the most important traits as well as the genetic parameters of its populations. Therefore, the objective of this work was to estimate genetic variability and assess the heritability for traits of agronomic interest in a velvet grass population collected in the State of Rio Grande do Sul, Brazil, through the evaluation of half-sib progenies, and to identify superior progenies for each trait.

MATERIAL AND METHODS

The experiment was accomplished at the Low Lands Experimental Station of Embrapa Temperate Agriculture in the municipality of Capão do Leão (lat 31º 52' 00" S, long 52º 21' 24" W, alt 13.24 m asl), State of Rio Grande do Sul, Brazil, during 2003. Sixty half-sib progenies collected from a population in the municipality of Bagé, State of Rio Grande do Sul, Brazil were studied. The Uruguayan commercial cultivar La Magnolia was used as a check.

Progenies were sown in trays on May 22nd, and trays were kept in the greenhouse. On July 10th, the seedlings were transplanted to the field. The experimental design was a randomized block, with three replications. Each plot was represented by one line with ten plants. Spacing among lines and among plants within lines was 0.3 m.

On September 29th, in the vegetative stage of the plants, the first assessments were made, measuring the natural height (NH, cm) and plant diameter (diameter, cm). Heading started at October 8th, and was evaluated weekly. Heading date (cycle) was measured as days from sowing to the emission of the first panicle. After flowering, two traits were assessed: final height (FH, cm), from the ground level until the insertion of the flag leaf, and tiller number (tillers): counting undertaken on November 27th. Heading date and final height were assessed in all plants and the other traits in three plants per plot.

Analyses of variance were performed on a plot mean basis with SAS software (SAS Institute 1994). Progeny means were compared by the Scott-Knot test, with Genes software (Cruz 2001). Comparisons with the check variety were made by the *t* test. Variance components were estimated by the analysis of variance method using the software SAS (SAS Institute 1994). Additive genetic variances were estimated as indicated for half-sib progenies (Hallauer and Miranda Filho 1988):

$$\sigma_A^2 = 4\sigma_{hsp}^2$$

where σ_{hsp}^2 is the variance component associated to the effects of half-sib progeny.

Narrow-sense heritabilities were estimated by the expression:

$$h^2 = \frac{\sigma_{hsp}^2}{\sigma_{hsp}^2 + \frac{\sigma^2}{r}}$$

where σ^2 is the variance component associated to the error and r is the number of replications.

The selection gain was estimated for a scheme involving the selection among progenies and recombination through remnant seeds and is shown in absolute and percentual values.

Simple phenotypic correlations were estimated among all traits.

RESULTS AND DISCUSSION

Significant differences among treatments occurred for all traits (Table 1). With regard to NH, the means of the progenies varied between 8.00 and 17.22 cm, and the

Table 1. Analysis of variance for natural height (cm), plant diameter (cm), heading date (days), final height (cm) and tiller number in half-sib progenies of velvet grass

S.V.	df	Natural height	Plant diameter	Heading date	Final height	Tiller number
Blocks	2	3.50	193.82	9.03	12.10	86.81
Progenies	59	7.82*	40.09*	87.11*	22.59*	150.89*
Error	113	4.86	27.25	7.12	9.75	54.08
C.V.		16.76	20.31	1.62	7.03	27.93
R^2		0.46	0.46	0.86	0.55	0.60

* P<0.05.

population mean was 13.14 cm (Table 2). Progenies were separated in two groups according to the Scott and Knott test. Plant diameter varied between 14.17 and 33.78 cm, and two groups were formed (Table 2). These traits may be selected as estimates of early production. In a Brazilian population of Italian ryegrass, correlations with early dry matter production were 0.50 for natural height and 0.54 for diameter (Mittelmann et al. 2006). Castro et al. (2003) found an even higher value for the diameter x dry matter yield correlation (0.68).

Table 2. Means of 60 half-sib progenies of velvet grass for natural height (cm) and plant diameter (cm)

Natural Height				Plant diameter			
Progeny	Mean	Progeny	Mean	Progeny	Mean	Progeny	Mean
25	17.22a*	225	12.67b	195	33.78a*	145	25.39b
105	17.00a*	185	12.56b	95	31.17a	220	25.33b
45	16.78a*	270	12.56b	185	30.50a	270	25.22b
125	16.67a*	80	12.44b	35	30.22a	65	24.83b
160	15.89a*	286	12.44b	210	30.06a	90	24.78b
95	15.44a	110	12.22b	155	29.89a	280	24.72b
140	15.44a	20	12.11b	15	29.78a	245	24.61b
90	15.00a	180	12.11b	201	29.67a	256	24.22b
75	14.89a	280	12.11b	105	29.61a	20	24.22b
145	14.56a	30	12.00b	150	29.56a	305	24.06b
56	14.44a	40	12.00b	215	29.39a	253	23.44b
65	14.44a	50	12.00b	160	28.83a	50	23.33b
201	14.33a	135	12.00b	165	28.78a	25	23.06b
130	14.22a	150	11.89b	286	28.61a	75	23.06b
190	14.11a	170	11.78b	170	28.61a	267	23.00b
35	14.00b	175	11.78b	175	28.61a	225	22.94b
215	14.00b	240	11.78b	40	28.50a	80	22.89b
70	13.83b	300	11.78b	290	28.39a	6	22.72b
290	13.67b	305	11.78b	140	28.33a	238	22.39b
15	13.56b	206	11.67b	45	28.28a	110	21.78b
210	13.44b	238	11.67b	240	28.28a	70	21.75b
245	13.44b	115	11.56b	100	27.89a	30	21.17b
155	13.33b	220	11.56b	190	27.61a	295	20.89b
6	13.22b	295	11.56b	180	27.22a	206	20.33b
120	13.22b	267	11.17b	10	26.78a	115	19.56b
165	13.22b	261	11.11b	56	26.06a	230	18.94b
86	13.11b	253	11.00b	261	25.94a	135	18.61b
100	13.11b	230	10.56b	125	25.61b	130	17.39b
256	13.11b	310	8.00b	86	25.61b	310	14.17b
10	13.00b	Mean	13.14	300	25.56b	Mean	25.70
195	12.78b	Control	12.11	120	25.44b	Control	22.82

Means followed by the same letter do not differ significantly through Scott & Knott test with 5% of significance.
* Differs significantly from the check through the t test with 5% of significance.

Heading date varied between 155.6 and 177.7 days and the population mean was 164.1 days (Table 4). For this trait, five groups of progenies were formed. Late flowering is usually desirable, extending the period of utilisation of the pasture. Final height varied among 38.03 and 50.13 cm, with a mean of 44.44 cm, and two groups of progenies were formed (Table 3). Concerning the number of tillers, the Scott and Knot test has pointed to only one group, despite the variation of the means, which ranged from 12.89 to 52.89 tillers per plant, and the significance through the F test (Table 3).

The check variety was the Uruguayan cultivar La Magnolia. For all traits, the population mean was superior to the check, indicating a potential for the selection of more adapted and productive cultivars. Regarding the cycle, there is a huge possibility of selection for late genotypes as well as for early genotypes, because there were also progenies with significantly lower means than the check.

Estimates of variance components associated to progeny effect and error are shown on Table 4. The estimates of additive variance, were 4.06; 17.62; 109.76; 17.61 and 132.84 for NH (cm), diameter (cm), heading date (days), final height (cm) and tiller number, respectively.

Among the studied traits, heading date has shown the highest heritability, of 92% (Table 4). This value indicates a low effect of the environment and that this trait is easy to select. It is possible that this population is segregating for a gene of large effect on the heading date. Final height and tiller number showed heritabilities that might be considered as intermediary values, while NH and diameter have low values (Table 4). It is important to consider that these heritability estimations are in a narrow sense, once the variance among half-sib progenies involves basically additive effects. In maize, the model plant to the study of allogamous species, average estimates of heritability of 56.9% for plant height, 57.9% for heading date and 71.9% for number of tillers were found (Hallauer and Miranda 1988). In meadow bromegrass (*Bromus riparius* Rehm.), Araújo and Coulman (2004) have found broad-sense heritabilities of 90% for height and 58% for diameter.

Estimated selection gains for one cycle of selection and 10% intensity indicated extremely favourable results, especially for tiller number, with a gain of 30.77% over the original population mean. The expected gains were of 8.28% for NH; 8.11% for diameter; 5.37% for heading date and 6.25% for final height (Table 4). Natural populations, which were not submitted to selection, usually show large

Table 3. Means of 60 progenies of half-sibs for heading date (days), final height (cm) and tiller number

Heading date				Final height				Tiller number			
Progeny	**Mean**	**Progeny**	**Mean**	**Progeny**	**Mean**	**Progeny**	**Mean**	**Progeny**	**Mean**	**Progeny**	**Mean**
310	177.70a*	100	161.98d	286	50.13a*	40	43.93b	240	52.89a*	270	26.00a
267	174.81a*	135	161.83d	225	49.90a*	245	43.92b	280	51.44a*	70	25.67a
201	174.02a*	56	161.80d	170	49.60a*	56	43.80b	10	36.33a*	86	25.56a
165	173.11a*	215	161.71d	100	48.63a	190	43.78b	165	35.33a*	190	25.11a
280	173.03a*	95	161.36d	201	48.62a	130	43.64b	95	34.44a*	110	24.78a
270	172.94a*	180	161.28d	86	48.57a	30	43.58b	215	33.11a*	290	24.78a
261	172.73a*	30	161.20d	105	47.56a	215	43.43b	267	32.83a	80	24.56a
225	172.17a*	65	161.08d	15	47.51a	185	43.42b	225	32.56a*	125	24.44a
238	171.50a*	86	161.04d	195	47.10a	253	43.34b	210	31.44a	261	24.11a
206	171.45a*	245	160.99d	210	47.05a	125	43.33b	195	31.22a	20	23.89a
170	171.43a*	35	160.94d	155	47.04a	50	42.98b	40	30.67a	253	23.67a
230	171.38a*	25	160.93d	165	46.82a	230	42.73b	45	29.89a	230	23.61a
256	171.03a*	6	160.59d	270	46.78a	267	42.71b	286	29.44a	56	22.56a
295	169.75b*	130	160.50d	261	46.72a	305	42.37b	105	29.44a	90	22.11a
253	169.09b	75	160.22e*	280	46.72a	35	42.21b	145	29.44a	65	21.11a
300	168.57b	305	159.96e*	75	46.70a	310	42.20b	185	29.11a	160	21.11a
210	168.32b	105	159.28e*	256	46.51a	150	42.12b	15	28.89a	75	20.44a
195	167.79b	40	159.17e*	135	46.47a	90	41.94b	206	28.67a	220	20.44a
190	166.33b	160	159.04e*	70	46.36a	240	41.87b	155	28.33a	238	20.44a
290	165.94c	120	158.93e*	206	46.23a	10	41.50b	175	28.33a	295	19.33a
286	165.68c	145	158.54e*	120	45.79a	20	41.29b	170	27.89a	310	19.33a
70	165.60c	15	157.72e*	115	45.35a	180	41.16b	256	27.56a	245	19.11a
175	165.60c	110	157.59e*	300	45.05a	6	40.70b	100	27.44a	6	18.89a
115	165.50c	90	157.55e*	140	44.89a	175	40.49b	120	27.44a	30	17.00a
220	165.38c	125	157.17e*	65	44.85a	110	40.20b	150	27.22a	180	16.78a
10	163.61c	20	157.04e*	45	44.65b	220	40.11b	140	27.11a	135	15.22a
155	163.51c	45	156.40e*	25	44.58b	80	40.01b	300	27.00a	50	14.67a
185	163.47c	80	156.22e*	95	44.51b	290	40.01b	201	26.56a	130	13.89a
50	163.30c	140	155.60e*	295	44.49b	238	38.03b*	115	26.56a	25	12.89a
240	162.57d	Mean	164.08	160	44.39b	Mean	44.44	305	26.44a	Mean	26.33
150	162.56d	Control	164.84	145	44.00b	Control	43.73	35	26.44a	Control	20.53

Means followed by the same letter do not differ significantly through Scott & Knott test with 5% of significance.
* Differs significantly from the control through the t test with 5% of significance.

genetic variability, allowing high gains in the first cycles of selection. Due to the high heritability, an extremely high genetic gain, of 8.81 days, is expected for heading date.

There were associations among traits, except for NH and tiller number, and heading date and tiller number. In general, the correlation values were low (Table 5). The highest value found was among the plant diameter and tiller number (r = 0.43). The NH and diameter traits measured in the initial stage of the plant development with the objective of selecting for early dry matter production has shown a certain degree of association (r = 0.35), besides having a negative correlation with heading date, which might point to a tendency of delayed flowering progenies for having a slower initial development. Mittelmann et al. (2004) have found similar correlations, and considered that they are of low value and do not hind the selection for an extended cycle of utilization of the pasture.

Data discussed here leads us to the conclusions that there is intrapopulation genetic variability for all the studied traits and gains after selection among half-sib progenies can be expected, and that a small number of genes control heading date variability in this population.

Table 4. Estimations of the variance components of progenies (σ^2_{hsp}) and error (σ^2), additive variance (σ^2_A), heritability and selection gain in absolute (Gs) and percentual (Gs%) value for natural height (NH, cm), plant diameter (cm), heading date (days), final height (cm) and tiller number

	Natural height	Plant diameter	Heading date	Final height	Tiller number
σ^2_{hsp}	1.01 ± 0.53	4.40 ± 2.77	27.44 ± 5.44	4.40 ± 1.47	33.21 ± 9.68
σ^2	4.86 ± 0.64	27.25 ± 3.59	7.12 ± 0.94	9.75 ± 1.29	54.08 ± 7.13
σ^2_A	4.06	17.62	109.76	17.61	132.84
h^2	0.38	0.32	0.92	0.57	0.64
Gs	1.09	2.08	8.81	2.78	8.10
Gs%	8.28	8.11	5.37	6.25	30.77

Table 5. Simple phenotypic correlations between traits in a velvet grass population

	Diameter	Heading date	Final height	Tiller number
Natural height	0.35**	-0.38**	0.23**	0.08
Diameter		-0.18*	0.26**	0.43**
Heading date			0.15*	0.10
Final height				0.28**

**,* Significant at 1% and 5% probability, respectively.

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Avaliação de progênies de meios-irmãos de capim-lanudo

RESUMO - *O capim-lanudo* (Holcus lanatus L.) *possui grande potencial de utilização como pastagem de inverno nas regiões subtropicais, devido a seu bom estabelecimento, persistência, produção, resistência ao frio, palatabilidade e capacidade de afilhamento. O objetivo deste trabalho foi estimar a variabilidade genética e a herdabilidade de caracteres agronômicos e identificar progênies superiores. Foram avaliadas 60 progênies de meios-irmãos, para altura (NH) e diâmetro da planta na fase vegetativa, duração do ciclo vegetativo (ciclo), altura final (FH) e número de afilhos. Houve diferença entre progênies para todos os caracteres. As estimativas de herdabilidade foram de 38%, 32%, 92%, 57% e 64% para NH, diâmetro, ciclo, FH e afilhos, respectivamente. O maior ganho genético estimado foi de 30,77 % para o número de afilhos. Existe variabilidade para todos os caracteres e são esperados ganhos na seleção entre progênies.*

Palavras-chave: Pastagem, *Holcus lanatus*, variância aditiva, herdabilidade, ganho de seleção.

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