Seed quality parameters of three interspecific hybrids of elephant grass x pearl millet[1]

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ABSTRACT - An interspecific hybrid resulting from the crossing of elephant grass (*Pennisetum purpureum* Schumach) x pearl millet (*Pennisetum glaucum* (L.) R. Brown) has been developed. This hybrid, however, revealed low phenotypic uniformity and low production of pure seeds. Through recurrent selection, two improved populations were obtained (genotypes Corte and Pastoreio). The aim of this study was assessing seed quality of the three hybrids (genotypes Corte, Pastoreio and Paraiso) by tests of: seed purity; seed germination; accelerated aging test, at 42 ºC; 1,000 seeds weight; drying curves; and sorption and desorption isotherms. Recurrent selection altered the seed size and increased initial quality of population for genotype Pastoreio. Drying curves for the three hybrids have shown similar behavior and reached moisture contents of 2.1%, 1.9%, and 1.8%, respectively, after 63 days. The accelerated aging test showed that hybrid Pastoreio was the most vigorous.

Index terms: *Pennisetum purpureum, Pennisetum glaucum,* drying, viability.

Parâmetros de qualidade de sementes de três híbridos interespecíficos de capim elefante x milheto

RESUMO - Foi desenvolvido um híbrido interespecífico resultante do cruzamento de capim- elefante (*Pennisetum purpureum* Schumach) *x* milheto (*Pennisetum glaucum* (L.) R. Brown) que revelou baixa uniformidade fenotípica e baixa produção de sementes puras. Através de seleção recorrente, foram obtidas duas populações melhoradas (genótipos: Corte e Pastoreio). O objetivo deste estudo foi avaliar a qualidade das sementes dos três híbridos (genótipos Corte, Paraíso e Pastoreio) por meio de testes de: pureza, germinação, envelhecimento acelerado, a 42 ºC; peso de 1.000 sementes; curvas de secagem; e isotermas de sorção e desorção. A seleção recorrente alterou o tamanho das sementes e aumentou a qualidade inicial da população para o genótipo Pastoreio. As curvas de secagem para os três híbridos mostraram comportamentos semelhantes e atingiram graus de umidade de 2,1%, 1,9% e 1,8% após 63 dias, respectivamente. O teste de envelhecimento acelerado mostrou que o híbrido Pastoreio foi o mais vigoroso.

Termos para indexação: *Pennisetum purpureum, Pennisetum glaucum,* secagem, viabilidade.

Introduction

Elephant grass (*Pennisetum purpureum* Schumach) is a tropical forage grass species with high potential for production of dry matter and is nowadays used for direct animal grazing or for complementary feeding during dry periods. It is widely distributed in Brazil and contributes for increases on milk production (Deresz, 1999). Only a few improved cultivars, however, are available, especially for uses in the rotational grazing system (Pereira et al., 2001).

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The majority of elephant grass cultivars available do not produce viable seeds, thus impairing its more intense use on pasture formations. Cultivars of pearl millet (*Pennisetum glaucum* (L.) R. Brown), however, normally present high production of viable seeds, but with low potential of forage production.

An interspecific hybrid between elephant grass and millet, named "Paraíso" (*Pennisetum purpureum x P. glaucum*) (Schank et al., 1996), was introduced in Brazil in 1995 by Matsuda Genetics and starting from that hybrid, improved populations were obtained by means of recurrent selection performed in the field during three consecutive years. Within the lines so obtained, plants were selected for collecting seeds for the genotypes Corte and Pastoreio. Seeds for Corte were collected from tall and robust plants presenting thicker stems; while for genotype Pastoreio seeds were obtained from shorter plants, with thinner and softer stems. Recurrent selection allowed attaining a high phenotypic uniformity, making possible the wide use of these seeds for establishments of commercial fields. The objective of this study was to assess seed quality of these three interspecific hybrids by using tests of: germination; accelerated aging, at 42 ºC; 1,000 seeds weight; drying curves; and sorption and desorption isotherms.

Material and Methods

Seeds from the original population of hybrid Paraiso and of hybrids Corte and Pastoreio, produced and provided by the company Matsuda Seeds and Animal Nutrition, were used in the experiment. Work samples were composed of: 1,118.3 g of seeds without purity for Corte hybrid; 1,056.9 g of seeds without purity for Paraiso hybrid; and 775.7 g of pure seeds for Pastoreio hybrid. The experimental work was carried out in the Post-harvest Technology Laboratory, College of Agricultural Engineering, State University of Campinas, State of São Paulo, Brazil.

The work samples were homogenized, placed into aluminum packages, hermetically sealed by thermo-welding, and then stored into a cold chamber at 5 ºC. After a five days period, for homogenization of seed moisture contents, tests for characterization of the work samples were started. Initially, seeds were subjected to determination of moisture content, purity, 1,000 seeds weight, germination and vigor. Immediately after, samples containing approximately 2,000 pure seeds of each hybrid were placed into desiccator containing silica gel or water, for reduction or increase of seed moisture contents, respectively.

Moisture content determination: moisture content was determined in wet basis, by using three subsamples of 1 g of pure seeds each, at temperatures varying from 130 ºC to 133 ºC, for 2 h, according to International Seed Testing Association (ISTA, 2006), into a forced air circulation oven.

Purity test: were performed using subsamples of 20 g of seeds each, for the samples of hybrids Corte and Paraiso. The objective of this test was to determine the work sample composition, which were sorted into three categories: pure seeds, other seeds and inert material (Brasil, 2009).

1,000 seeds weight: was determined based on the Rules for Seed Analysis (RSA) (Brasil, 2009) by using eight subsamples of 100 pure seeds each, which were weighed in a 0.0001 g precision analytical balance.

Germination test: was performed using 4 x 50 pure seeds for each hybrid, uniformly distributed into 11 cm x 11 cm x 3.5 cm germination boxes (gerbox) on top of four sheets of filter paper moistened with sterile distilled water, with a mass equivalent to 2.5 times the mass of dry substrate. The gerbox containing seeds were then placed into a incubator with a 16/8 h (L/D) photoperiod and alternated temperatures of 20 ºC and 30 ºC (16 h at 20 ºC and 8 h at 30 ºC, with white light) and the counts were performed at the 3rd and 10th days, according to RSA.

Vigor test: was performed into BOD type environmental chamber, at constant temperature of 42 ºC and 100% RH, during time periods of 48, 72, and 96 hours. After those time periods, seeds were subjected to germination test (Usberti, 1990).

Drying and rehydration of seeds: moisture contents of seeds were adjusted to four levels at temperature of 25 ºC. All adjustments were performed starting from initial moisture content of seeds with the aid of desiccators: one containing silica gel, to decrease moisture content; and another containing a water film, to increase moisture content. The drying process was performed during a period of 63 days; while rehydration period did not exceeded 30 hours.

The equation adopted for obtaining the desired moisture contents (Equation 1) was the same used by Francisco et al. (2007), where: M_f is the final moisture

content (%; wet basis); PB_i = initial gross mass, in grams; T = tare weight of container; M_i = initial moisture content (%; wet basis); and PB_f = final gross mass, in grams.

(Equation 1)

$$M_f = \frac{(PB_i - T) * M_i + 100 * (PB_f - PB_i)}{PB_f - T} \quad (1)$$

Water activity (A_w): the free water content is expressed by the activity of the water (A_w), which is obtained by the relation between the balanced water vapor pressures exerted on the seed and the pure water vapor pressure, at the same temperature (Mohsenin, 1986). The knowledge of isotherms of hygroscopic balance moisture of seed is essential, since it is directly linked to processes of storage, drying, and commercialization (Roa and Rossi, 1977).

Determination of A_w was performed at 25 ºC with the aid of a portable pawKit (water activity meter) apparatus. For each degree of moisture content, obtained with the drying process and five levels of humidification (four levels + initial humidity), three subsamples of approximately 3.0 grams of pure seeds each was used.

An ANOVA computer program was used to test differences among hybrids and mean comparisons of different characteristics were made.

Results and Discussion

In the seed purity analysis, impurities such as debris of leaves and stems as well as little stones (smaller than 5 mm) were found. Due to presence of aristae, the purity analysis was manually performed by pressing seeds, one by one, with the fingernail to detect the presence of embryo. The percentages found were 43.6% for seeds of hybrid Paraiso and 19.8% for seeds of hybrid Corte. As the seeds of hybrid Pastoreio have arrived to the laboratory with the purity analysis already performed, 100% of seeds were considered as pure (Table 1).

Table 1. Percentage of pure seeds obtained for the hybrids Paraiso, Corte and Pastoreio through seed purity test.

Hybrids	Corte		Paraiso		Pastoreio	
	Grams	%	Grams	%	Grams	%
Initial mass	20.00		20.03		20.00	
Pure seeds	3.92	19.80	8.67	43.60	20.00	100.00
Other seeds	0.00		0.00		0.00	
Inert material	15.91		11.24		0.00	
Total impurities	15.91	80.20	11.24	56.50	0.00	0.00
Final mass	19.83		19.91		20.00	
Variation	0.17	0.84	0.12	0.60	0.00	0.00

By the test of mass of 1,000 seeds and by purity analysis, performed in the work samples, approximately 147,000 pure seed kg^{-1} were obtained for hybrid Paraiso and 311,000 pure seeds kg^{-1} were obtained for hybrid Pastoreio. Such variations on values of this quality parameter were also observed by Cavalcante-Filho and Usberti (2008) in different cultivars of *Brachiaria brizantha* and other tropical grasses.

In relation to size of seeds and according to the number of seed found per gram, the hybrid Corte has presented seeds with smaller size than the hybrids Paraiso and Pastoreio (Table 2). Therefore, for obtaining 1 g of seeds, a larger seed number for the hybrid Corte was needed, in relation to the remaining hybrids.

The accelerated aging test has shown statistically significant difference in the 96 h period for hybrids Corte and Paraiso (Table 3). By comparing seeds of hybrids, only at the 72 h period, it can be noticed that the vigor percentages for hybrid Corte was lower than for the remaining; and that for the other periods there were not statistically significant differences.

The germination tests for different moisture contents have not shown statistically significant differences for the hybrids Corte and Pastoreio (Table 4). The highest germination values were obtained for moisture contents of: 9.1% for hybrid Corte; 8.2% and 17.0% for hybrid Paraiso; and 9.2% and 7.4% for hybrid Pastoreio(Table 4).

Table 2. Mean mass of 1,000 seeds and number of pure seeds per gram obtained from eight replications of 100 seed each for the hybrids Paraiso, Corte and Pastoreio.

Replications(g)	Hybrids		
(100 seeds each)	Corte	Paraiso	Pastoreio
1	0.203	0.280	0.311
2	0.200	0.283	0.300
3	0.221	0.301	0.329
4	0.196	0.290	0.313
5	0.217	0.294	0.322
6	0.214	0.305	0.333
7	0.179	0.304	0.334
8	0.209	0.300	0.329
Mean (g)	0.205	0.295	0.321
Standard deviation	0.014	0.009	0.012
Variance	0.0002	0.0001	0.0001
Number of seeds g^{-1}	488	339	311
CV (%)	6.662	3.192	3.767
Mass of 1,000 seed (g)	2.048	2.946	3.212

Table 3. Percentage of seed vigor obtained by the accelerated aging test, performed into BOD type environmental chamber, for the hybrids Paraiso, Corte and Pastoreio.

Time into BOD (hours)	% Vigor at 42 ºC		
	Corte	Paraiso	Pastoreio
0	63.5 aA*	70.5 aA*	70.5 aA*
48	58.0 abA	60.5 abA	76.0 aA
72	58.0 abA	68.0 abB	61.0 aAB
96	51.5 bA	57.5 bA	62.0 bA

*Means followed by the same small letter in the columns and capital letters in the lines do not differ statistically by F test at $p \leq 0.05$.

The lowest values for germination were obtained with the lowest moisture contents (2.1%; 1.9%; and 1.8%, for genotypes Corte, Paraiso, and Pastoreio, respectively) (Table 4); what shows that very low moisture contents interfere on germination percentage, even after slow rehydration. Such results disagree from results obtained in a study performed by Xiaorong et al. (1998) for other plant species, where the efficiency of drying on silica gel for preserving seed viability was proved.

On Figure 1, the drying curves for the three hybrids are presented. Through these curves it is possible to observe that until the fifth day of the drying period, the moisture content of seeds rapidly decreased, and that after the 40th day, it remained constant.

Table 4. Germination percent obtained for seeds of three different interspecific hybrids (*Pennisetum purpureum* x *Pennisetum glaucum*) with six different levels of moisture content.

Moisture content (%)	Hybrid Corte Germination (%)	Moisture content (%)	Hybrid Paraiso Germination (%)	Moisture content (%)	Hybrid Pastoreio Germination (%)
16.0	63.5 a*	17.0	79.0 ac*	18.0	66.5 a*
11.9	61.5 a	13.2	77.0 ac	14.2	70.0 a
10.7	63.5 a	10.6	70.5 ab	11.2	70.5 a
9.1	68.0 a	9.3	73.0 abc	9.2	71.0 a
7.7	62.5 a	8.2	79.5 c	7.4	71.0 a
2.1	58.5 a	1.9	67.0 b	1.8	65.5 a

*Means followed by the same small letter in the columns and capital letters in the lines do not differ statistically by F test at $p \leq 0.05$.

The sorption and desorption isotherms computed for the hybrids assessed are shown on Figure 2. In a general way, the three curves have shown similar trends, thus reiterating that the recurrent selection has not altered the chemical composition of the seeds, for all hybrids.

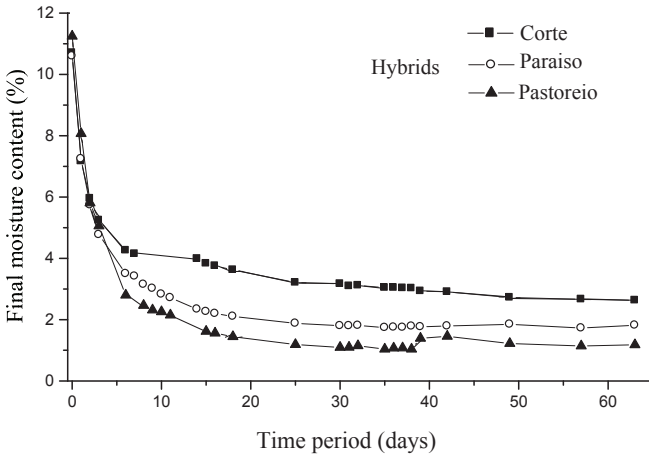

Figure 1. Drying curves for seeds of three different interspecific hybrids (*Pennisetum purpureum* x *Pennisetum glaucum*).

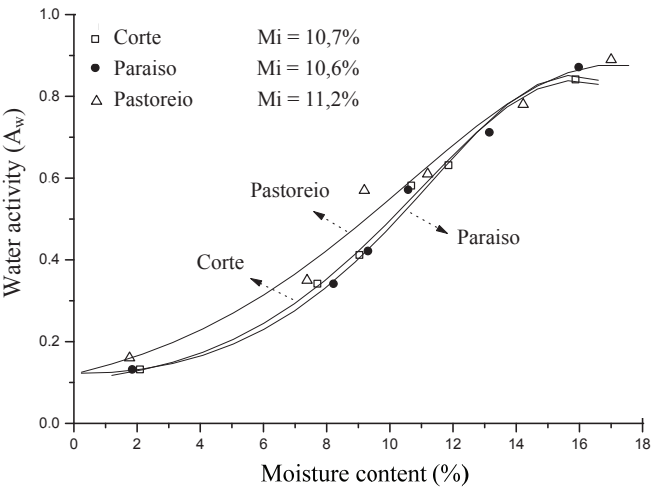

Figure 2. Sorption and desorption isotherms at 25 ºC for seed of three different interspecific hybrids (*Pennisetum purpureum* x *Pennisetum glaucum*): Paraiso, Corte and Pastoreio. (M_i - initial moisture content).

Conclusions

The accelerated aging test is able to detect statistically significant differences of vigor in seeds of hybrids resultant from the crossing between *Pennisetum purpureum* x *Pennisetum glaucum* after aging periods between 72 and 96 hours.

The recurrent selection increases the size of seeds of hybrids resultant from the crossing between *Pennisetum purpureum* x *Pennisetum glaucum*.

Low initial moisture contents interfere on seed germination percent of hybrids resultant from the crossing between *Pennisetum purpureum* x *Pennisetum glaucum*.

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