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CG PICAÇO: a new cultivar of sudangrass with high forage performance and seed yield

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Abstract – *A new cultivar of sudangrass [Sorghum sudanense (Piper) Stapf.] was developed by the method of selection of individual plants with progeny testing. The most important traits are high forage performance, good leaf:stalk ratio, and high seed yield.*

Key words: Sorghum sudanense *(Piper) Stapf., plant breeding, forage traits.*

INTRODUCTION

Numerous studies have been carried out to select and genetically improve forage crops, always seeking to associate high yields of dry matter with bromatological quality (Neumann et al. 2011). Therefore, the pressure of natural or artificial selection in species facing animal production aim at obtaining genotypes with emphasis on forage traits, mainly on green and total dry matter and leaf dry matter (Assis et al. 2008). Thus, studies hardly ever aim at a combined selection regarding genetic gain in seed yield (Lopes and Franke 2011).

In Brazil, few forage cultivars are currently commercially available, most derived from apomictic reproduction. Therefore, they are genetically homogeneous and do not generate new variation. This is a threat to national security due to the possible emergence of new pests and most serious diseases (Jank et al. 2011). On the other hand, most tropical forages of agronomic interest have large genetic variability, which can be exploited in the selection of new cultivars with desirable traits (Araújo et al. 2008). Sudangrass [*Sorghum sudanense* (Piper) Stapf.] is a forage species which has been increasingly used in southern Brazil. It presents annual cycle, and grows in tropical and temperate climates, being tolerant to acidity and low fertility soils, with high biomass yield and optimal recovery after cutting and grazing (Bibi et al. 2010).

The advancement of sudangrass in areas previously occupied by other annual species is a consequence of the high resistance of the species to water deficits, which notoriously occurs during the summer (Pacheco et al. 2013). This culture is widely used for ground cover due to its large biomass, and therefore, it leaves great amount of sudangrass trash on soil. Moreover, its use as forage is relatively new; thus, there are few cultivars registered (MAPA 2014). Its great potential for biomass yield, its tolerance to drought, heat, acid and low fertility soils, its disease resistance, and its ability to compete with weeds (Silva et al. 2014) have been notorious to the production of interspecific hybrids (*Sorghum bicolor* x *Sorghum sudanense*), combining the benefits of both species. Zamfir et al. (2001) reinforce that the biomass yield of sudangrass is superior to that of pearl millet and maize, and so is the ability on roots and shoots growth. In addition, Tomich et al. (2004) did not find differences between the forage potential of sorghum hybrids compared with sudangrass; therefore, they present forage yield similar to a hybrid and with a significantly reduced cost for obtaining seeds.

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PEDIGREE AND BREEDING METHODS

The cultivar CG PICAÇO was obtained by the method of selection of individual plants within the "common" original population with subsequent progeny test (VCU tests). In the year 2009, three populations of "common" sudangrass, originated from different edaphoclimatic regions, were sown in the field evidencing great genetic variability within and between populations. Two populations were collected in the fields of Cegil Agro Seeds Company, in São Borja-RS and in Campos de Júlio-MT, and another one was collected by farmers in the municipality of Melo (province of Cerro Largo, Uruguay). The seeds of each population were sown 0.45 m between plants and between lines, on a density of three to four seeds per pit-hole. The established order sought to force competition between plants in the pit-hole, and the one which expressed greater competitive ability in the vegetative stage would remain. There was selection pressure of approximately 3% in 1272 of plants obtained from three populations, based on forage traits and seed yield. In the field, the main trait of analysis was tillering, and it was selected plants which had at least 10 fertile tillers (viable panicles). These plants were cut close to the soil surface at the physiological maturity of seeds, separating the panicles for kiln drying (40 ^{o}C) until seed moisture reached close to 13%. The rest of the genotype of each plant was weighed in order to assume the potential for biomass yield. Before the cutting, the main panicle of each plant was identified, harvested and packed in paper bags for drying and taken to the laboratory for analysis of traits related to inflorescence components, such as panicle length, panicle mass, number of grains per panicle, mass of grains per panicle, fertility and panicle harvest index. Thus, after analysis of selected genotypes, plants with higher performance for the simultaneous production of forage and seeds were sown in the field, in 2010, in individual plots. In that year, selection occurred between plots, and the selected ones needed to present great uniformity and superior performance. The selected plots were submitted to value of cultivation and use (VCU) test in the following years. The cultivar was called CG 236AR09 in field.

PERFORMANCE

Due to its great potential in biomass and seed yield, in the years 2011 and 2012, CG 236AR09 line was tested in VCU tests, which were carried out at three different locations: Augusto Pestana (lat 28º 28' 51'' S, long 53º 58' 07'' W, alt 385m asl) and São Borja (lat 28º 54' 40'' S, long 55º 29' 06'' W, alt 137m asl), in Rio Grande do Sul, and

Table 1. Performance of forage cultivars value for cultivation and use assay, carried out in 2011, in three different soil and climatic regions

Genotype	TFM*	FML	FMS	TDM	DML	DMS	SY	TFM	TDM	SY	TFM	TDM	SY
					kg ha $^{-1}$			% about JUMBO			% about SUDAN		
Year 2011 - Augusto Pestana, RS													
CG PICAÇO	52914	22691	30223	14153	6085	8068	2890	132	140	76	131	148	189
AG 2501C	41645	20417	21228	11218	5364	5854	3820	104	111	101	103	117	250
JUMBO	39957	19875	20082	10107	4828	5279	3794	100	100	100	99	106	248
SUDAN	40269	16405	23864	9562	3750	5812	1530	101	95	40	100	100	100
ADR500	33314	14859	18455	7456	3119	4337	800	83	74	21	83	78	52
Year 2011 - São Borja, RS													
CG PICAÇO	55724	26371	29353	15540	6812	8728	3001	137	136	85	146	173	147
AG 2501C	41147	20104	21043	12079	5677	6402	3760	101	105	107	108	134	184
JUMBO	40549	19884	20665	11468	5504	5964	3529	100	100	100	106	128	173
SUDAN	38269	15112	23157	8990	3441	5549	2045	94	78	58	100	100	100
ADR500	31751	13735	18016	6990	3007	3983	1462	78	61	41	83	78	71
Year 2011 - São José do Cedro, SC													
CG PICAÇO	49118	22924	26194	13412	6012	7400	2906	119	108	103	130	147	144
AG 2501C	40981	19452	21529	11882	5435	6447	3111	99	96	110	109	130	154
JUMBO	41436	20094	21342	12438	5886	6552	2830	100	100	100	110	137	140
SUDAN	37685	15746	21939	9110	3947	5163	2021	91	73	71	100	100	100
ADR500	31114	15147	15967	6892	3013	3879	1484	75	55	52	83	76	73

* TFM= Total Fresh Matter; FML= Fresh Matter of Leaves; FMS= Fresh Matter of Stalks; TDM= Total Dry Matter; DML= Dry Matter of Leaves; DMS= Dry Matter of Stalks; SY= Seed Yield.

São José do Cedro (lat 26º 27' 46'' S, long 53º 32' 53'' W, alt 627m asl), in Santa Catarina. Tests were carried out in a randomized block design with four replications. Each experimental unit, which included a genotype to be tested, consisted of 5 rows of 5 m of length, spaced 0.20 m apart, in order to compose a plot of 5 m². Seeding rate was 25 kg of seeds ha^{-1} for cultivars of sudangrass and pearl millet, and 12 kg seed ha^{-1} for sorghum cultivars. The evaluated traits was the total yield of fresh matter (TFM) by cutting 1 m^2 of each plot of which plants reached 60 – 65 cm height, leaving a residue of 10 cm above the soil. Samples of each genotype were weighed to obtain the TFM, and then, 100 grams were separated for performing botanical separation. Therefore, it was analyzed the fresh matter of leaves (FML) and fresh matter of stalks (FMS), and after, they were converted to kg ha^{-1}. Subsequently, samples were placed to dry in an oven with forced ventilation at 65 °C until constant weight to be analyzed again, obtaining estimates of total dry matter (TDM), dry matter of leaves (DML), and dry matter of stalks (DMS).

For analysis of seed yield, another experiment was carried out in order to obtain greater reliability of selection applied on components of seed yield of the cultivars. Thus, the experiment was carried out in randomized block design with three replications. Each experimental unit, which included a genotype to be tested, consisted of 5 rows of 5 m length, spaced 0.20 m apart to compose a plot of 5 m². The seeding rate was 25 kg seed ha^{-1} for cultivars of sudangrass and pearl millet, and 12 kg seed ha^{-1} for sorghum cultivars. To estimate the yield of seeds, it was carried out harvesting of the three central rows of each plot, comprising an area of 3 m^2, as soon as seeds reached the stage of physiological maturity. Panicles were weighed and threshed with estimated values in kg ha^{-1}. For not having available seeds of this cultivar (IPA Sudan 4202) registered at MAPA when the study was carried out, it was used as control, in both experiments, one pearl millet cultivar (ADR 500 - "SuperMassa"), two forage sorghum hybrid cultivars (AG2501C and JUMBO) and the sudangrass "common" population. In these same year in Augusto Pestana, the experiment was carried out with the purpose of doing the DHS tests (Differentiation, Homogeneity and Stability), comparing with the same cultivars control.

Table 1 presents the forage yield and seed yield of CG PICAÇO cultivar compared to controls. In 2011, in all environments evaluated, the new cultivar of sudangrass was superior to all the controls, including sorghum hybrid, for all forage traits analyzed, providing greater supply of total

Table 2. Performance of forage cultivars value for cultivation and use assay, carried out in 2012 in three different soil and climatic regions

Genotype	TFM*	FML	FMS	TDM	DML	DMS	SY	TFM	TDM	SY	TFM	TDM	SY
		kg ha^{-1}						% about JUMBO			% about SUDAN		
Year 2012 - Augusto Pestana, RS													
CG PICAÇO	154490	66431	88059	28533	14672	13861	2541	127	133	105	143	147	146
AG 2501C	113573	52244	61329	19830	9849	9981	2693	94	92	111	105	102	155
JUMBO	121333	54600	66733	21507	11884	9623	2431	100	100	100	112	111	140
SUDAN	107983	50752	57231	19367	8746	10621	1736	89	90	71	100	100	100
ADR500	96930	39741	57189	17327	7911	9416	620	80	81	26	90	89	36
Year 2012 - São Borja, RS													
CG PICAÇO	117883	53047	64836	19830	10143	9687	3121	123	124	112	132	134	167
AG 2501C	91293	42908	48385	14193	7263	6930	2971	95	89	106	102	96	159
JUMBO	96061	45149	50912	15993	9031	6962	2794	100	100	100	107	108	150
SUDAN	89482	38477	51005	14810	6807	8003	1864	93	93	67	100	100	100
ADR500	81004	32402	48602	13200	6295	6905	756	84	83	27	91	89	41
Year 2012 - São José do Cedro, SC													
CG PICAÇO	126224	60588	65636	19450	9929	9521	3268	120	121	94	137	142	146
AG 2501C	99836	44926	54910	15347	7781	7566	3251	95	95	93	108	112	145
JUMBO	105197	47339	57858	16096	8887	7209	3494	100	100	100	114	117	156
SUDAN	92203	40569	51634	13723	6270	7453	2243	88	85	64	100	100	100
ADR500	82572	34680	47892	12062	5634	6428	1114	78	75	32	90	88	50

* TFM= Total Fresh Matter; FML= Fresh Matter of Leaves; FMS= Fresh Matter of Stalks; TDM= Total Dry Matter; DML= Dry Matter of Leaves; DMS= Dry Matter of Stalks; SY= Seed Yield.

dry matter and leaf per hectare. However, for the seed yield, hybrids were more productive. Moreover, the CG PICAÇO cultivar showed higher yield performance compared to "common" sudangrass, indicating the highest genetic gain from selection process.

In the second year of evaluation of VCU test (2012), due to the favorable year of production, all genotypes had higher performance than the previous year. This fact did not change the behavior of genotypes since the cultivar CG PICAÇO had forage performance superior to the other controls at all locations evaluated, and hybrids of sorghum obtained higher seed yield mean (Table 2).

Table 3 presents the mean for each genotype in both years of evaluation for different environments. Thus, again, the cultivar CG PICAÇO was superior to the control cultivars at the three locations. In this sense, the environment Augusto Pestana was the most favorable for cultivars performance; however, the environment of São Borja was the most restrictive. In the overall analysis, gathering the means of years and locations, the best control was the hybrid cultivar of forage sorghum, called JUMBO, with mean yield of 74089 and 14602 kg of fresh and dry matter per hectare, respectively. On the other hand, the cultivar CG PICAÇO obtained yields of 92726 and 18486 kg of fresh and dry matter ha^{-1}, respectively, exceeding by 25 and 27% the control. However, despite producing greater amount of leaf ha^{-1} and greater amount of dry matter ha^{-1}, CG PICAÇO presents lower leaf:stalk ratio (0.93:1) than sorghum AG2501C (0.95:1) and JUMBO (1,10:1), but much higher than the "common" sudan (0.77:1) and pearl millet ADR 500 (0.82:1). It is noteworthy that leaf:stalk

Table 3. Mean performance of cultivars of forage value for cultivation and use assay, carried out in the years of 2011 and 2012, in three different soil and climatic regions

Augusto Pestana, RS Mean													
Genotype	**TFM**	**FML**	**FMS**	**TDM**	**DML**	**DMS**	**SY**	**TFM**	**TDM**	**SY**	**TFM**	**TDM**	**SY**
	---------- kg ha $^{-1}$ ----------							% about JUMBO			% about SUDAN		
CG PICAÇO	103702	44561	59141	21343	10379	10965	2716	129	135	87	140	148	166
AG 2501C	77609	36330	41279	15524	7607	7918	3257	96	98	105	105	107	199
JUMBO	80645	37237	43408	15807	8356	7451	3113	100	100	100	109	109	191
SUDAN	74126	33579	40547	14465	6248	8217	1633	92	92	52	100	100	100
ADR500	65122	27300	37822	12391	5515	6877	710	81	78	23	88	86	43
São Borja, RS Mean													
Genotype	**TFM**	**FML**	**FMS**	**TDM**	**DML**	**DMS**	**SY**	**TFM**	**TDM**	**SY**	**TFM**	**TDM**	**SY**
	---------- kg ha $^{-1}$ ----------							% about JUMBO			% about SUDAN		
CG PICAÇO	86804	39709	47094	17685	8478	9208	3061	127	129	97	136	149	157
AG 2501C	66220	31506	34714	13136	6470	6666	3366	97	96	106	104	110	172
JUMBO	68305	32516	35789	13731	7268	6463	3162	100	100	100	107	115	162
SUDAN	63876	26795	37081	11900	5124	6776	1955	94	87	62	100	100	100
ADR500	56378	23068	33309	10095	4651	5444	1109	83	74	35	88	85	57
São José do Cedro, SC Mean													
Genotype	**TFM**	**FML**	**FMS**	**TDM**	**DML**	**DMS**	**SY**	**TFM**	**TDM**	**SY**	**TFM**	**TDM**	**SY**
	---------- kg ha $^{-1}$ ----------							% about JUMBO			% about SUDAN		
CG PICAÇO	87671	41756	45915	16431	7971	8461	3087	120	115	98	135	144	145
AG 2501C	70409	32189	38219	13615	6608	7007	3181	96	95	101	108	119	149
JUMBO	73317	33716	39600	14267	7387	6881	3162	100	100	100	113	125	148
SUDAN	64944	28158	36786	11417	5109	6308	2132	89	80	67	100	100	100
ADR500	56843	24914	31929	9477	4324	5154	1299	78	66	41	88	83	61
Overall Mean (Years + Places)													
Genotype	**TFM**	**FML**	**FMS**	**TDM**	**DML**	**DMS**	**SY**	**TFM**	**TDM**	**SY**	**TFM**	**TDM**	**SY**
	---------- kg ha $^{-1}$ ----------							% about JUMBO			% about SUDAN		
CG PICAÇO	92726	42009	50717	18486	8942	9544	2955	125	127	94	137	147	155
AG 2501C	71413	33342	38071	14092	6895	7197	3268	96	97	104	106	112	171
JUMBO	74089	34490	39599	14602	7670	6932	3145	100	100	100	110	116	165
SUDAN	67648	29510	38138	12594	5494	7100	1907	91	86	61	100	100	100
ADR500	59447	25094	34353	10654	4830	5825	1039	80	73	33	88	85	55

* TFM= Total Fresh Matter; FML= Fresh Matter of Leaves; FMS= Fresh Matter of Stalks; TDM= Total Dry Matter; DML= Dry Matter of Leaves; DMS= Dry Matter of Stalks; SY= Seed Yield.

ratio obtained for each cultivar is derived from values of MDL divided by the MDS overall analysis (Table 3). In relation to seed yield, the highest yield was obtained by AG2501C hybrid, with 3268 kg ha^{-1}, followed by JUMBO (3145 kg ha^{-1}) and CG PICAÇO (2955 kg ha^{-1}). When comparing cultivar CG PICAÇO with the "common" sudan, it is evident the great genetic gain from selection process, reaching 55% more seed yield, from 1907 to 2955 kg ha^{-1}. Moreover, it increased yield in 37 and 47% more on fresh and dry matter, and established better leaf:stalk ratio. It is important to note that, although the two years of evaluation are different, as well as the evaluation site, the cultivar CG PICAÇO showed better performance in forage traits in all environments, revealing an important technology product to be available to Brazilian farmers, especially to those that produce milk and meat on pasture.

SEED MAINTENANCE AND DISTRIBUTION

CG PICAÇO is registered in the Ministry of Agriculture, Livestock and Food Supply, number 32394 (MAPA 2014). Cegil Agro Seeds (Celso L. Arenhardt & Cia Ltda.) is responsible for maintaining the cultivar genetics and basic seeds. Seeds are sold to producers accredited by the company.

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