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Productivity, nutritional quality and phenotypical stability of varieties of silage sorghum in Uberlândia, MG

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Sorghum (S*orghum bicolor* (L.) Moench) is a good alternative for silage, especially in places with water scarcity and high temperatures, due to their morphological and physiological characteristics. Proper management contributes both to productivity and to the quality of forage. The present study was conducted with the following objectives: To evaluate the agronomic and bromatological performance of varieties of sorghum silage as well as their phenotypic stability in the early and late (off) seasons of planting in the region of Uberlândia, Minas Gerais. The experiment was performed at the *Capim Branco* Experimental Farm of the Federal University of Uberlândia - UFU located in Uberlândia - MG. In this experimental area forage was planted at the normal, seasonal time and in the off season. A randomized block design was used with 25 treatments and three replications. Flowering, dry matter yield, plant height, Acid Detergent Fiber and Neutral Detergent Fiber of the cultivars were all found to be affected by the time of planting. The SF11 variety was found to be superior in terms of productivity and fiber quality regardless of the season. The evaluation of dry matter stability demonstrated superiority among the varieties: SF15, SF11, SF25, PROG 134 IPA, 1141572, 1141570 and 1141562. As for the stability of fiber quality, the 1141562 variety stood out.

Key words: Photoperiod, digestibility, genotype, *Sorghum bicolor*.

INTRODUCTION

Sorghum (*Sorghum bicolor*, L. Moench) is a crop that is increasing every day in Brazilian agriculture. As a very high energy grass, it is useful because of its high levels of productivity, digestibility, and adaptation to warm and dry environments, in comparison with other species. Sorghum adapts easily to different conditions

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of soil fertility, is tolerant of high temperatures and survives water stress (Miranda et al., 2010).

Intensification of production processes in beef and dairy cattle in Brazil have increased the need for feed, including forage that is quantitatively and qualitatively better for the animals, especially during periods of dry pasture. In this respect, the production of high quality silage is a viable alternative (Machado et al., 2011).

The production of sorghum for forage has been playing an increasingly important role in recent years in Brazil and the world, standing out as a species resistant to adverse environmental conditions (Rezende et al., 2011). Plant breeding programs have developed various cultivars adapted to various types of soil and climate. These include varieties developed by the Brazilian Agricultural Research Agency (Embrapa, 2009) and the Agricultural Research Agency of Pernambuco (IPA) (Silva et al., 2012).

The cultivation of silage sorghum outside the traditional period may allow its expansion in Brazil. However, most commercial sorghum materials were improved in Brazil for photoperiod insensitivity, only genotypes of silage sorghum are sensitive to photoperiod (Silva et al., 2005-1).

Although there has been genetic improvement in sorghum, there is still a limited availability of cultivars with desirable characteristics such as high production of fodder and high nutritional value. There is, thus, need to develop suitable cultivars that will present positive interaction with local environmental conditions. For these reasons, the aim of this study was to evaluate the agronomic and qualitative characteristics of sorghum varieties for silage as well as their adaptability and stability in the region of Uberlândia, Minas Gerais.

MATERIALS AND METHODS

The experiments were performed at the *Capim Branco* Experimental Farm of the Federal University of Uberlândia – UFU, located in Uberlândia, Minas Gerais, Brazil. The experimental area is located on the perimeter of the city of Uberlândia. The area has an altitude of 843 m, latitude 18º 54' 41" South and a tropical savanna climate (Koppen climate Rating: Aw). The soil of the area is characterized as clayey dystrophic dark Red Latosol.

The experiments used a randomized complete block design with three replications. The experimental plots were composed of two lines of 5 m, with spacing of 0.7 m between lines and a total area of each plot of 7 m². In the experiments at both planting times a total of 25 varieties of silage sorghum were evaluated, 18 from the Embrapa, Maize and Sorghum Breeding Program and 7 commercial cultivars (controls).

The soil was prepared in the conventional manner, plowed twice and disked. Fertilizer was applied at 322 kg ha^{-1} of mineral fertilizer 8-28-16. The sorghum seed was then planted, at a depth of 3 to 4 cm. Plants were thinned 10 to 15 days after emergence, for the equivalent of a population of 100,000 plants ha^{-1} and were top dressed with 250 kg ha^{-1} of urea and 250 kg ha^{-1} of Potassium chloride (KCl). Weed control was done with an herbicide (Atrazine) and manual weeding. Irrigation was used only to obtain the initial stand and then stopped, to simulate the climatic conditions of the off season. Irrigation was not necessary for harvest.

The management of caterpillars was conducted with organophosphate insecticides or pyrethroids, applied following the dosage recommended by the manufacturer. Birds were controlled by covering the panicles with nylon screens. No chemicals were necessary for disease control since the experiment used resistant cultivars.

The characteristics evaluated in the field were: flowering (number of days, measured by the time by which more than 50% of the plot had panicles with more than 50% pollen release); plant height (m, measured by average plant height from the insertion of the panicle to the ground, of flowering plants) and dry matter (t ha^{-1}). Harvest was done manually by cutting the stems at a height of 10 cm from the ground when the grains of the panicles were in the milky or "dough" stage. This time of harvest was determined because it is a time when dry matter can adequately be measured, for good quality silage. Ten plants were taken at random from each plot, crushed in a chopper and manually homogenized. A subsample of this material was used for evaluation of the dry matter. Weighing was performed immediately and the samples were placed in a forced ventilation oven at 65°C for 72 h. They were then ground in a Willey mill (1 mm sieve), for chemical analysis.

Fiber content was determined for neutral detergent fiber (NDF) and acid detergent fiber (ADF) according to techniques described by Silva and Queiroz (2002). The chemical analysis was conducted at the Animal Nutrition Laboratory (LAMRA) of the Faculty of Veterinary Medicine - FAMEV of the Federal University of Uberlândia.

Evaluation of the data was initially carried out using ANOVA and the F test, considering only the times of planting where there were observations according to the following mathematical model for analysis of variance:

$$Yij = \mu + gi + bj + eij$$

where: Yij = observations of the plot in the block; μ = general average; gi = the effect of the genotype; bj = the effect of the block; and eij = the effect of unmeasured factors of the genotype in the block.

For the assessment of genotype environment interaction, analysis of variance was performed by the following mathematical model:

$$Yijk = \mu + gi + j + gaij + bk / aj + eijk$$

where: Yijk = observations of the plot in the block; μ = the general average; gi = the effect of the genotype; j = the environmental (time of planting) effect; gaij interaction = the effect of the genotype with the environment; bk / j = the effect of the block in the environment; eijk = the effect of unmeasured factors in the proportion received by the genotypes in the environment within block.

Analyses of variance and F tests were carried out with the help of Microsoft Excel software, according Banzato and Kronka (1992). Means for grouping the varieties used the Scott and Knott test with the Genes program (Cruz, 2013). Once the presence of genotype environment interaction G x E (significant F test) was detected, we proceeded to the analysis of phenotypic stability proposed by Annichiarico (1992). To apply this methodology, we first calculated the averages of the two environments and then obtained the percentages of cultivars in relation to the environmental averages. We then calculated the averages for each variety, in percentages, and the standard deviations of these averages. In turn, the stability parameter (ii), or confidence index was estimated by the following equation:

Table 1. Summary of the analysis of variance for flowering data (flower), plant height (height), dry matter (DM), acid detergent fiber (ADF) and neutral detergent fiber (NDF) of 25 sorghum varieties grown in season and off season environments.

Variation sources	Gl (df)	Squared averages									
		Flower		Height		Dry Matter		ADF		NDF	
		Season	Off season	Season	Off season	Season	Off season	Season	Off season	Season	Off season
Cultivar	24	253.05*	183.03*	1.64*	1.20*	49.80*	35.12*	191.85*	64.58	70.79*	170.12*
Bloc	2	1.44	0.57	0.09	0.15	0.18	3.91	14.88	22.40	28.70	0.45
Resídual	48	3.35	2.28	0.02	0.03	6.54	4.66	28.55	46.31	20.43	43.26
CV (%)		2.67	3.00	5.79	8.98	20.03	26.31	12.28	19.06	6.32	9.49

Gl: Degrees of freedom; *: Significant at 5% of error probability by F test.

Ii=Yi-Z (1-a) si; where: Yi is the average percentage of the i^th^ genotype with respect to each environmental time in question; Z (1-a) is the standardized value of the normal distribution in which a cumulative distribution function reaches the value (1-a). The level of significance adopted in this case was 0.5, and si is the standard deviation of the percentages of each genotype.

RESULTS AND DISCUSSION

Significant differences were found among all of the sorghum varieties evaluated: flowering (flower), plant height (height), dry matter (DM), acid detergent fiber (ADF) and neutral detergent fiber (NDF) in both season and off season environments, with the exception of the ADF in the off season (Table 1). Since the ratios between the highest and the average squared residuals were less than seven, it was possible to perform an analysis of variance (Banzato and Kronca, 1992). In this analysis, we observed the interaction between genotypes and environments ($p<0.01$) for all evaluated characteristics, as well as significant differences among genotypes for height and dry matter and between environments for flower, height and dry matter ($p<0.01$) (Table 2).

The coefficients of variation (CV%) ranged between 2.8 and 22.56% indicating good to moderate experimental precision. According to Pimentel Gomes (2000), in field experiments, coefficients of variation of less than 10% are considered low, that is, the experiment has high accuracy; 10% to 20% CVs are considered medium, resulting in good precision; 20 to 30% are considered high, meaning low accuracy and above 30% is regarded very high, indicating very low precision.

Coefficients of variation ranging between 14.1 and 33.4 were found by Chielle et al. (2013) in evaluating 23 cultivars of sorghum silage. Neumann et al. (2010) found CV% of 10.34% for ADF and 3.49 for NDF. Albuquerque et al. (2012) found a coefficient of variation of 6.93% for plant height, similar to the present study.

Regarding the number of days of flowering, it was found that all varieties had a longer growing period during the season, in relation to the off season, except for the 12F042224 and 12F042226 varieties which did not differ statistically between season and off season values (Table 3). In the season, the number of days to flowering ranged from 49 to 82 days. The later varieties were 1141572, 1141570 and 12F042066 and the earlier ones were 12F042224 and 12F042226.

Chielle et al. (2013) evaluated 23 silage sorghum cultivars in Rio Grande do Sul in 2011-2012 and found flowering values ranging from 65 days for the BR304 cultivar up to 84 days for FEPAGRO 18, with an average of 77 days. In the off season the number of days to flowering fluctuated between 42 and 67 and the early flowering varieties were 9929036, 9929030, FEPAGRO 18, FEPAGRO 11, 9929012, 9929026, 947216 and 947030 and the later PROG 134 IPA, SF15 and SF11.

In relation to plant height, it was noted that all varieties had higher averages when planted in November, with the exception of 12F042226, 12F042224 and PROG 134 IPA, varieties that did not differ significantly between the two periods (Table 4). The varieties of sorghum grown in the off season were earlier and shorter compared to those planted in the normal season. This can be explained by the influence of the photoperiod on the induction of flowering and hence the stoppage of plant growth. The plant height results at that time ranged from 1.26 to 3.46 m. The tallest varieties were:

Table 2. Summary of analysis of variance for flowering data (flower), plant height (height), dry matter (DM), acid detergent fiber (ADF) and neutral detergent fiber (NDF) for 25 sorghum varieties at two different times of planting.

Variation sources	Gl (Df)	Squared averages				
		Flower	Height	Dry matter	ADF	NDF
Cultivar	24	281.37	2.31*	64.66*	116.51	154.29
Time	1	12622.51*	27.34*	782.31*	2295.32	176.45
Cul x Amb	24	154.71*	0.53*	20.25*	139.94*	86.64*
Bloc	2	1.72	0.23	2.22	17.59	12.60
Resídual	96	2.81	0.03	5.60	37.43	31.84
CV (%)		2.82	7.11	22.56	15.44	8.01

Gl: Degrees of freedom; *: Significant at 5% of error probability by F test.

Table 3. Average number of days to flowering for 25 varieties of silage sorghum grown in season and off season.

Varieties	Flowering (days)	
	Season	Off season
9929036	68.66 Ad	42.33 Bf
9929030	66.00 Ae	42.66 Bf
12F042224	49.00 Bh	52.66 Ac
12F042150	73.00 Ac	54.66 Bc
FEPAGRO 18	65.66 Ae	42.66 Bf
FEPAGRO 19	71.66 Ac	45.33 Be
FEPAGRO 11	68.00 Ad	43.00 Bf
9929012	67.66 Ad	42.33 Bf
9929026	64.00 Ae	43.00 Bf
947216	70.66 Ad	44.66 Bf
947030	67.66 Ad	44.00 Bf
947254	73.33 Ac	47.66 Be
947072	54.33 Ag	46.00 Be
947252	63.33 Ae	49.33 Bd
SF15	74.33 Ac	66.66 Ba
SF 11	78.66 Ab	67.33 Ba
SF 25	74.00 Ac	62.00 Bb
PROG 134 IPA	74.66 Ac	65.00 Ba
1141572	82.00 Aa	52.33 Bc
12F042066	81.00 Aa	47.66 Be
12F042226	49.00 Ah	47.33 Ae
1141570	81.00 Aa	52.33 Bc
1141562	78.33 Ab	48.33 Be
BRS 506	60.66 Af	54.66 Bc
BRS Ponta Negra	59.33 Af	53.33 Bc

Means with the same lower case letter vertically within each time belong to the same group, according to the Scott-Knott test. Horizontally, means with the same capital letter do not differ by F test at 5% probability.

SF15, SF 11 and SF 25 and the shorter: 9929030 and 9929026. In the season there was greater plant height, with oscillations from 1.71 to 3.96 m. The varieties that were notably shorter were: 12F042226, 9929026 and 12F042224 and the notably taller ones: FEPAGRO 19, SF15, SF 11, SF 25, 1141572,

Table 4. Average plant height (m) of 25 varieties of silage sorghum grown in season and off season.

Varieties	Plant height (m)	
	Season	Off season
9929036	2.93^{Ac}	1.63^{B}
9929030	2.13^{A}	1.30^{B}
12F042224	1.81^{A}	1.86^{Ad}
12F042150	2.93^{Ac}	2.13^{Bc}
FEPAGRO 18	3.36^{Ab}	2.00^{Bd}
FEPAGRO 19	3.78^{Aa}	2.10^{Bc}
FEPAGRO 11	3.30^{Ab}	2.00^{Bd}
9929012	2.33^{A}	1.70^{B}
9929026	1.95^{A}	1.26^{B}
947216	2.50^{Ad}	1.63^{B}
947030	2.46^{Ad}	1.53^{B}
947254	2.60^{Ad}	1.86^{Bd}
947072	2.33^{A}	1.66^{B}
947252	2.26^{A}	1.50^{B}
SF15	3.73^{Aa}	3.43^{Ba}
SF 11	3.81^{Aa}	3.36^{Ba}
SF 25	3.96^{Aa}	3.46^{Ba}
PROG 134 IPA	2.80^{Ac}	3.06^{Ab}
1141572	3.68^{Aa}	2.16^{Bc}
12F042066	3.78^{Aa}	1.70^{B}
12F042226	1.71^{A}	1.83^{Ad}
1141570	3.83^{Aa}	2.20^{Bc}
1141562	3.90^{Aa}	2.23^{Bc}
BRS 506	2.83^{Ac}	2.30^{Bc}
BRS Ponta Negra	2.16^{A}	1.63^{B}

Means with the same lower case letter vertically within each time belong to the same group, according to the Scott-Knott test. Horizontally, means with the same capital letter do not differ by F test at 5% probability.

12F042066, 1141570 and 1141562. These results registered taller results than those found by Chielle et al. (2013) who obtained plant heights ranging between 1.13 and 2.54 m in the evaluation of 23 silage sorghum cultivars in Rio Grande do Sul in 2011-2012; and found by Silva et al. (2007) evaluating sorghum cultivars in Goiás with average plant heights from 1.21 to 1.55 m.

In terms of the dry matter (t ha^{-1}) it was observed that ten varieties did not differ significantly between the planting dates and the others had higher yields in the seasonal planting compared to the off season (Table 5). For seasonal plantings, yields fluctuated between 7.66 and 21.69 t ha^{-1} with the most productive varieties: SF15, SF11, 1141572, 12F042066, 1141570 and 1141562. In the off season, the results ranged from 3.91 to 15.81 t ha^{-1}. The varieties that had higher yields, SF15 and SF11, were not influenced by the environment. Silva et al. (2007) evaluated the BR 700, 1F305, Volumax, VDH 422 cultivars and Nutrigrain forage sorghum at three locations, finding an average of 5.9 t ha^{-1} of dry matter, a result well below that found in the present study.

For Albuquerque et al. (2012), the production of sorghum dry matter is directly related to plant height. Taller cultivars can achieve higher productivities. However, dry matter productivity is also associated with the management adopted and the capacity inherent to the species or variety.

Regarding the bromatological analysis, when we compared the ADF values (%) between the two planting periods there were significant differences for eleven varieties that had higher values for the seasonal than in the off season planting (Table 6). These results were explained by the lower amounts of grain at harvest, due to the attacks of birds in the area. For the seasonal planting, the ADF mean values ranged between 29.97 and 61.68%. Macedo et al. (2012) found average levels of ADF in sorghum silages ranging from 48.69 to 55.19% due to nitrogen rates.

Table 5. Average dry matter yield (t ha^{-1}) for 25 varieties of silage sorghum grown in season and off season.

Varieties	Dry matter (t ha^{-1})	
	Season	Off season
9929036	13.99^{Ab}	4.35^{Bc}
9929030	11.16^{Ab}	4.69^{Bc}
12F042224	7.66^{Ac}	8.61^{Ac}
12F042150	11.70^{Ab}	10.37^{Ab}
FEPAGRO 18	13.04^{Ab}	4.81^{Bc}
FEPAGRO 19	9.17^{Ac}	3.91^{Bc}
FEPAGRO 11	13.56^{Ab}	5.99^{Bc}
9929012	8.15^{Ac}	6.88^{Ac}
9929026	7.87^{Ac}	3.95^{Bc}
947216	13.77^{Ab}	7.19^{Bc}
947030	9.44^{Ac}	5.15^{Bc}
947254	10.80^{Ac}	6.67^{Bc}
947072	10.66^{Ac}	9.08^{Ac}
947252	9.46^{Ac}	4.98^{Bc}
SF15	17.24^{Aa}	15.03^{Aa}
SF 11	17.94^{Aa}	15.81^{Aa}
SF 25	14.46^{Ab}	10.97^{Ab}
PROG 134 IPA	11.62^{Ab}	13.07^{Ab}
1141572	21.69^{Aa}	11.61^{Bb}
12F042066	17.37^{Aa}	6.45^{Bc}
12F042226	8.00^{Ac}	7.20^{Aca}
1141570	19.72^{Aa}	12.21^{Bb}
1141562	19.26^{Aa}	8.46^{Bc}
BRS 506	12.11^{Ab}	7.83^{Bc}
BRS Ponta Negra	9.40^{Ac}	9.83^{Ab}

Means with the same lower case letter vertically within each time belong to the same group, according to the Scott-Knott test. Horizontally, means with the same capital letter do not differ by F test at 5% probability.

These values were above what is recommended.

In the off season crop, FDA values ranged from 27.27 to 44.40%. These results were close to those obtained by Cândido et al. (2002). ADF levels reported for green sorghum forage in several studies range from 28.7 to 45.6% (Gontijo Neto et al., 2004).

Higher values of NDF were found for the 12F042150, SF15, SF 25, PROG 134 IPA and 1141570 varieties. These presented higher values in the seasonal crop than in the off season. With the exception of the 9929030 variety, which showed a higher value in the off season, the others were not affected by the time of planting (Table 7). The average values of NDF at harvest ranged between 58.25 and 80.17%. In the off season, values were between 54.86 and 81.36%.

According to Gontijio Neto et al. (2004) various studies with green sorghum have reported NDA values ranging from 51.6 to 67.4%. Neumann et al. (2010) found NDF values ranging from 66.58 to 70.01% and Macedo et al. (2012) reported that with increasing doses of nitrogen, average values of NDF ranged from 62.12 to 68.17%. All of these results corroborate the present findings.

To estimate the stability of the genotypes, the Annichiarico methodology (1992) was applied. Varieties were evaluated in relation to: flowering characteristics, plant height and dry matter. Those that had superior adaptability and stability were: SF15, SF 11, SF 25, PROG 134 IPA, 1141572, 1141570, 1141562 and 12F042150 (Table 8).

The bromatological characteristics, ADF and NDF, indicated the varieties with greater adaptability and stability to be: 9929012, 947254, 947072, 947252 and 1141562, but only the last variety showed lower values, that is, optimal fiber, which directly influences the quality of silage (Table 8).

Souza et al. (2013), the cultivar BRS506 also showed general and specific adaptability and stability

Table 6. Average content of acid detergent fiber (ADF%) of 25 varieties of silage sorghum grown in season and off season.

Varieties	FDA (%)	
	Season	Off season
9929036	47.98^{Ab}	29.85^{Bb}
9929030	34.40^{Ac}	37.15^{Aa}
12F042224	33.85^{Ac}	32.93^{Ab}
12F042150	52.15^{Aa}	33.60^{Bb}
FEPAGRO 18	36.13^{Ac}	33.68^{Ab}
FEPAGRO 19	47.89^{Ab}	40.71^{Aa}
FEPAGRO 11	36.53^{Ac}	32.98^{Ab}
9929012	47.08^{Ab}	43.97^{Aa}
9929026	36.97^{Ac}	39.03^{Aa}
947216	37.58^{Ac}	39.74^{Aa}
947030	37.26^{Ac}	33.40^{Ab}
947254	54.49^{Aa}	40.50^{Ba}
947072	46.22^{Ab}	38.52^{Aa}
947252	41.42^{Ac}	44.40^{Aa}
SF15	61.68^{Aa}	33.95^{Bb}
SF 11	46.08^{Ab}	35.72^{Bb}
SF 25	53.45^{Aa}	34.12^{Bb}
PROG 134 IPA	45.00^{Ab}	27.27^{Bb}
1141572	45.43^{Ab}	28.52^{Bb}
12F042066	47.11^{Ab}	34.56^{Bb}
12F042226	29.97^{Ac}	40.82^{Aa}
1141570	46.59^{Ab}	27.78^{Bb}
1141562	51.70^{Aa}	36.74^{Ba}
BRS 506	31.21^{Ac}	34.80^{Ab}
BRS Ponta Negra	39.72^{Ac}	37.61^{Aa}

Means with the same lower case letter vertically within each time belong to the same group, according to the Scott-Knott test. Horizontally, means with the same capital letter do not differ by F test at 5% probability.

Table 7. Average contents of Neutral Detergent Fiber (NDF%) of 25 varieties of silage sorghum grown in season and off season.

Varieties	NDF (%)	
	Season	Off season
9929036	70.47^{Ab}	68.07^{Ab}
9929030	71.37^{Ba}	81.36^{Aa}
12F042224	68.86^{Ab}	70.64^{Aa}
12F042150	77.86^{Aa}	58.99^{Bb}
FEPAGRO 18	62.66^{Ab}	66.50^{Ab}
FEPAGRO 19	67.32^{Ab}	71.31^{Aa}
FEPAGRO 11	67.66^{Ab}	66.61^{Ab}
9929012	75.86^{Aa}	75.45^{Aa}
9929026	73.84^{Aa}	78.77^{Aa}
947216	72.46^{Aa}	79.34^{Aa}
947030	76.43^{Aa}	74.77^{Aa}
947254	72.70^{Aa}	76.47^{Aa}
947072	73.46^{Aa}	75.69^{Aa}
947252	80.17^{Aa}	76.66^{Aa}

Table 7. Cont'd.

SF15	76.34 Aa	63.26 Bb
SF 11	70.05 Ab	63.59 Ab
SF 25	76.66 Aa	60.06 Bb
PROG 134 IPA	67.17 Ab	54.86 Bb
1141572	68.42 Ab	70.70 Aa
12F042066	71.67 Aa	64.95 Ab
12F042226	70.14 Ab	66.63 Ab
1141570	69.06 Ab	57.09 Bb
1141562	74.59 Aa	79.10 Aa
BRS 506	58.25 Ab	62.51 Ab
BRS Ponta Negra	73.48 Aa	69.37 Aa

Means with the same lower case letter vertically within each time belong to the same group, according to the Scott-Knott test. Horizontally, means with the same capital letter do not differ by F test at 5% probability.

Table 8. Estimates of phenotypic stability parameters using the Annicchiarico method (1992), with a Confidence index (Wi), of 25 varieties of silage sorghum grown in season and off season.

Varieties	Confidence index				
	Flower	Height	DM	ADF	NDF
9929036	89.04	85.69	70.36	91.79	98.33
9929030	88.31	66.09	66.49	86.74	105.23
12F042224	81.61	70.90	73.79	82.24	98.05
12F042150	107.07	101.39	102.26	102.02	92.42
FEPAGRO 18	88.16	102.57	72.00	86.50	90.20
FEPAGRO 19	94.51	110.30	55.07	111.27	96.85
FEPAGRO 11	89.66	101.86	83.17	86.54	95.10
9929012	88.59	80.70	69.98	112.79	106.97
9929026	87.87	63.04	52.30	92.45	106.48
947216	93.15	81.14	93.84	94.02	105.39
947030	90.89	77.43	66.20	88.05	107.22
947254	98.48	89.51	82.33	117.07	104.35
947072	82.93	80.20	91.85	106.73	104.76
947252	94.05	74.21	64.82	104.14	111.08
SF15	115.73	139.72	149.76	109.42	96.03
SF 11	120.52	140.71	156.46	101.85	93.67
SF 25	112.55	145.76	119.50	103.95	92.97
PROG 134 IPA	115.06	112.09	111.93	84.69	83.70
1141572	108.78	111.49	150.20	87.41	97.65
12F042066	101.90	96.87	96.27	100.33	95.72
12F042226	78.36	68.03	70.36	82.82	96.74
1141570	108.33	114.19	150.56	86.79	86.74
1141562	101.63	116.01	117.77	107.80	107.35
BRS 506	94.61	101.49	95.02	79.63	84.16
BRS Ponta Negra	92.45	75.75	87.78	95.60	100.92

for favorable and unfavorable environments for the highest yield and fresh biomass. Silva et al. (2005), using another method of stability and adaptability to evaluate fresh and dry biomass yield in forage sorghum cultivars, identified BRS506, among the materials evaluated, as the most suitable to favorable and unfavorable environments, in addition to presenting the highest yield for fresh biomass (49.3 t ha^{-1}).

Conclusion

The flowering, dry matter yield, plant height, ADF and NDF are all affected by the time of planting and the variety. Regarding productivity and fiber quality, the SF11 variety was superior at both times of planting. For stability of the dry matter yield: SF15, SF11, SF25, PROG 134 IPA, 1141572, 1141570 and 1141562 stood out. As for the stability of the quality of fiber (ADF and NDF), the 1141562 variety was found to be superior.

Conflict of Interests

The authors have not declared any conflict of interests.

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