



Yield performance for sorghum cultivars under thermal and saline stress in the Brazilian semi-arid region

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ABSTRACT

This work aims to evaluate forage sorghum in the semi-arid region of Pernambuco, where salinity and water stress are present. The study was based on the premise that good management makes the soils arable and able to agricultural practices. Because it has an "aggressive" root system and a certain tolerance to salinity, sorghum can explore deeper layers of soil in search of water and nutrients and produce surprising yields. It also has protective cutin on the stalk and leaf surface, resulting in less water loss through transpiration. These factors allow it to better adapt to the adversities of this environment, such as temperatures above 40°C, water and salt stress, and even so, it has shown satisfactory yields when compared to other Poaceae. This study aimed to evaluate 12 forage sorghum cultivars with different agronomic characteristics, under irrigation with water of up to 1.4 dS.m⁻¹ from the Saco reservoir, during two successive cycles, characterizing the spring and summer seasons, in 2015 and 2016, respectively. The experiment was conducted in the experimental area of the IPA, Serra Talhada - PE. The design used was randomized blocks in a 2x12 factorial scheme, the first factor corresponding to two cropping systems (with and without mulch (C/C and S/C) and the second, 12 sorghum cultivars shown in Table 1. There were 22 treatments with 2 replications, totaling 44 experimental units. Each plot consisted of 3 rows 5 meters long, spaced 0.80m apart. The planting density after thinning was 15 plants per linear meter. At the end of the experiment, it was found that the cover cropping system (C/C) provided better yields of up to 30% in the 1st cycle and up to 64% in the 2nd cycle among the systems studied; the 2nd cycle was favored by rainfall which provided yields of up to 68.85 and 61.6 t.ha⁻¹ MV and 24.10 and 21.56 t. ha⁻¹ DM, respectively, in both the C/C and S/C cultivation conditions; the IPA SF 15 and BRS Ponta Negra varieties were responsible for the highest yields, with rates of over 120 and 100 t.ha⁻¹ DM (C/C) and 86 and 90 t.ha⁻¹ DM (S/C), respectively; in the 1st and 2nd cycles, the S/C cultivation system provided higher yields for the SF17, 2502 and SF190 varieties, respectively.

KEYWORDS: forage sorghum, production efficiency, abiotic stresses, soil and climate factors.

1 INTRODUCTION

The uncertainties surrounding the agricultural calendar because of climate change across the planet have been a cause for concern for the scientific community, mainly due to the rise in average temperatures and rainfall volumes over time and space (when and how much it will rain), which bring with them other biotic and abiotic factors that can cause stresses, compromising the productive potential of cultivated plants.

The agronomic scientific community has focused its studies on plants that can express fundamental characteristics for coping with such stresses.

In the northeastern semi-arid region, sorghum has been the focus of these studies by IPA and EMBRAPA - Semiárido, with significant results in terms of tolerance to these stresses and, above all, productivity. Given the yields of the genetic materials IPA SF 15; IPA 467-4-2 (forage); IPA 2502 (dual purpose); IPA - 73001011 (tannin-free graniferous); IPA 4202 Sorghum Sudan (HCN-free for direct grazing and haymaking) and BRS Ponta Negra (TABOSA et al., 2013a).

It is also worth mentioning that in the semi-arid region of northeastern Brazil, a considerable percentage of its arable area is on crystalline soils, with shallow soils and the presence of salts, especially sodium, compromising the development of most plants of commercial interest.

Thus, studies are needed to enable both the proper management of these soils and the implementation of technologies to enhance the productive potential of these plants.

One of these technologies that has been implemented and has shown significant results is the use of mulch on fallow soil at the Serra Talhada Experimental Station (EEST) and the Serra Talhada Academic Unit (UFRPE-UAST).

The technique of using mulch in the experimental areas of EEST and UAST is already widely used in large production centers under the name of Direct Planting in Straw (PDP). This technology was initially designed to control erosion and is currently focused on sustainability, with benefits for reducing the erosive impact of rainfall, greater infiltration, soil and water conservation, less soil heating, less evapotranspiration, greater biological activity, nutrient cycling, an increase in organic matter, with greater comfort for plants, factors favored by less use of machinery and implements, permanent soil cover and crop rotation. (SIMPLÍCIO et al., 2020).

These studies have been fundamental in providing producers with sorghum genetic materials with grain and fodder production potential for the region in question (semi-arid), as well as for other regions of Brazil, as is the case with the materials above, which have shown surprising yields evaluated in other regions of Brazil, including the IPAs SF 15 and 730-1011 and the BRSSs Ponta Negra and 506.

In this scenario, since sorghum has multiple tolerance characteristics to biotic and abiotic stresses, it responds with high forage yields and regrowth capacity, adapting perfectly to adverse situations. As a result, sorghum crops are increasingly occupying areas where maize crops do not perform satisfactorily.

Therefore, according to Elias et al., (2019) who observed the behavior of 10 genetic materials of forage sorghum, they found higher values of rainfall use efficiency (EUC) under less favorable rainfall conditions (73.4 mm of rain) in the experimental period to produce 82.52 kg (DM).ha⁻¹.mm⁻¹.

However, Perazzo et al., (2013) found higher EUC values, between 94.23 and 126.25 kg (DM).ha⁻¹.mm⁻¹, with an accumulated rainfall of 115 mm and nitrogen fertilization of 100 Kg.ha⁻¹. In this case, Nitrogen application increased sorghum phytomass production, when higher soil humidity is present.

In the context of sustainability, it is a fact that direct planting on straw (PDP) is a soil and water conservation system resulting in several advantages, ensuring more regular production of cultivated plants, and should therefore be an important practice, especially in semi-arid regions, where the evapotranspiration demand of plants increases due to high temperature and incidence of solar radiation and low air humidity, contributing to greater water demand. (SANTOS et al., 2012).

In this context, the PDP system, by considerably reducing evapotranspiration rates and the temperature in the root environment, among other factors, favors plant development in hot climate regions. However, information on the adoption of no-till farming for sorghum in the semi-arid region of Pernambuco still needs more studies for it to be effectively consolidated.

Based on this proposal, it is suggested that for establishing a production system, in the case of sorghum, in addition to choosing cultivars adapted to the different growing conditions, the use of appropriate cultural practices is fundamental.

This study aimed to evaluate the agronomic characteristics of sorghum cultivars in two cultivation systems - with and without the use of mulch under conditions of saline stress, in the

semi-arid region of Pernambuco, and consequently to obtain information that will enable the recommendation of cultivars that are better adapted to biotic and abiotic stresses.

2 MATERIALS AND METHODS

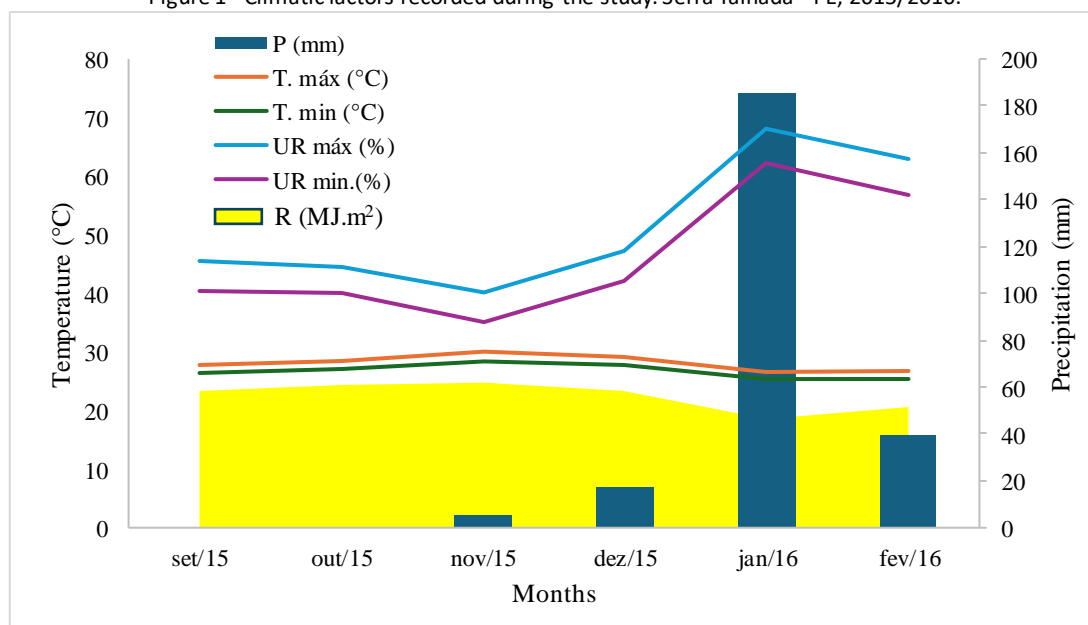
2.1 Characterization of the experimental area

The studies were carried out from September 2015 to February 2016, under field conditions, therefore outside the recommended agricultural calendar, on the premises of the Serra Talhada Experimental Station (EEST), belonging to the Agronomic Institute of Pernambuco - IPA. Located under the geographical coordinates 7° 56,332' 50" S and 38° 17,418' 34" O, in the municipality of Serra Talhada, Microregion of Sertão do Pajeú, Mesoregion of Sertão Pernambucano.

The local climate is BSw_h', according to the Koppen classification, with summer/autumn rainfall. Average annual rainfall is 632 mm and average monthly air temperatures vary between 23.6 and 27.7°C, minimum temperatures between 18.4 and 21.6°C and the highest temperatures occur from October to January, with values exceeding 32°C (SECTMA, 2006).

Figure 1 shows some of the main climatic factors recorded by the Automatic Meteorological Station of the National Meteorological Institute (INMET) Network, located within the experimental area of UAST/UFRPE during the study period, which contributed decisively to the behavior of the genetic materials studied and which will be discussed in due course.

Figure 1 - Climatic factors recorded during the study. Serra Talhada - PE, 2015/2016.



Source: INMET (2023); adapted by authors (2023).

2.2 Statistical design

The statistical design used was randomized blocks in a 2x12 factorial scheme, the first factor corresponding to two cropping systems (with and without mulch (C/C and S/C) and the second, 12 sorghum cultivars shown in Table 1. There were 22 treatments with 2 replications, totaling 44 experimental units. Each plot consisted of four rows five meters long, spaced 0.80m apart.

Table 1. Parameters evaluated in the sorghum genetic materials under different growing conditions. Serra Talhada - PE, 2015/2016.

Genotypes	Natura Category				
	V/F/S	V/D.P	V/P	V/F	P/F
BRS-Ponta Negra	x				
BRS-506				x	
13F02(1141570)		x			
13F03(1141562)					x
13F04(1141572)					x
13F05(1140562)				x	
IPA-2502	x				
IPA-SF 11					x
IPA-SF 15				x	
IPA-EP 17	x				
FEPAGRO-17					x
FEPAGRO-190				x	

V= broom; F=forage; D.P=double aptitude; S= saccharine. Source: Authors (2023).

2.3 Chemical analysis and soil preparation

The chemical analysis of the soil collected in the experimental area at a depth of up to 40 cm was carried out by the Soil Fertility Laboratory of the Agronomic Institute of Pernambuco - IPA and revealed the following results: pH (water) = 6.80; P (Mehlich I extractor) = 40.0 mg.dm⁻³; K⁺ = 0.45 cmolc.dm⁻³; Ca²⁺ = 5.50 cmolc.dm⁻³; Mg²⁺ = 1.6 cmolc.dm⁻³; Al = 0.0 cmolc dm⁻³.

The experimental area was prepared conventionally with one plowing to incorporate the spontaneous vegetation and two harrowing operations to even out the soil and facilitate sowing and seedling emergence. The water supplied for irrigation was taken from the "açude do Saco".

2.3 Sowing and application of treatments

Sowing was carried out at a depth of approximately 5.0 cm in the second half of September 2015. Thinning was carried out 25 days after sowing, leaving 15 plants per linear meter.

At this point, a layer of approximately 5.0 cm of dry straw was added, effectively covering the area between the rows of the system in both blocks.

The straw was collected from the spontaneous vegetation around the experimental area and had a mixture of plants from the Poaceae Sp. and Fabaceae Sp. families, with a much higher percentage (~ 80%) of Poaceae Sp., characterizing slower degradation due to the higher C/N ratio.

2.4 Fertilizer management

Foundation and top dressing fertilizations were carried out according to the soil analysis and the fertilization recommendation manual for the state of Pernambuco (CAVALCANTI, 2008). Phosphorus (P) and potassium (K) were applied entirely in the foundation, with 2/3 of the nitrogen (N) applied at the time of sowing and 1/3 in top dressing 40 days after sowing.

The methodology used for the second cycle complied with the following criteria: 48 hours after the first cycle, 2/3 of the (N) and 1/3 of the (K) recommended by the soil analysis were applied on the surface and covered with soil to avoid losses through volatilization or erosion. It should be noted that no phosphorus (P) was applied for the second cycle.

2.5 Cultivation

Pest and disease control was similar for all the treatments, always using preventive manual scavenging, without the use of chemical products. It is worth noting that no problems were observed with pests and diseases that could compromise crop productivity.

Weed control was carried out differently for each cropping system. In the system with mulch (C/C), weeds, when present, were pulled out manually, while in the system without mulch (S/C) weeds were eliminated by weeding with a hoe, avoiding their interference in the development of the crop.

2.6 Irrigation management

Irrigation was carried out using a drip system, with emitters with a flow rate of 4.0 L h⁻¹, spaced 0.20 m apart. The irrigation rate was calculated based on the crop's daily ETC, using the method proposed by FAO56, using data supplied by INMET, from the automatic weather station at UFRPE/UAST, located in Serra Talhada, PE. The water used came from the "saco" reservoir, ~200m from the experimental area, with an electrical conductivity of up to 1.4 dS.m⁻¹.

2.7 Data collection

Evaluations were carried out on the two central rows, discarding half a meter at each end of each row, giving a useful area of 6.4 m².

The grains were harvested at the mushy to mealy stage (when most of the plants normally have between 35% and 40% dry mass). The agronomic characteristics assessed were: plant height (AP); days to 50% flowering; green mass production (PMV) and dry mass production (PMS).

The plant cycle was carried out manually in the useful area of the plots at a height of 15 cm from the ground, allowing for greater vigor in the regrowth. Weighing was carried out in the field to immediately determine the PMV per plot. At random, two plants harvested from the useful area were weighed, cut, and dehydrated in a forced air ventilation oven at 65°C until constant weight to determine the SMP. $SMP \cdot h^{-1}$ was determined by the product of SMP and SPM.

2.8 Statistical analysis

The data obtained was subjected to analysis of variance and the means were compared using the Tukey test at a 5% probability level, using the statistical software R version 4.0.2.

3 RESULTS AND DISCUSSION

The average plant height values for the first and second cycles, days to flowering, and cycle classification for the two growing conditions are shown in Table 2. The treatments had a significant influence on these variables, but there was no interaction between them. For the average plant height values in the first cycle, the cultivars PN, 13F02, and IPA SF15 were superior to the others and equal to each other. In the second cycle, the cultivars with the highest average plant height were IPA SF15, 13F02, and IPA SF11. The cultivars did not show any significant difference in the number of days to flowering, however, the growing conditions caused a difference in the days to flowering of the materials, 13F02, 506, SF190, 13F04, 13FS0, where they showed a significant reduction in the number of days to flowering.

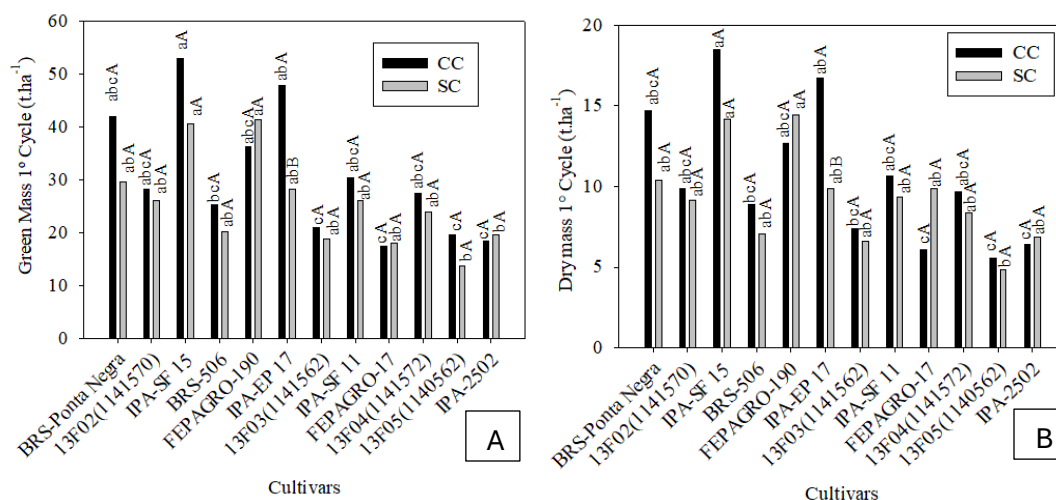
Table 2. Main characteristics of forage sorghum genetic materials evaluated under different growing conditions. Serra Talhada - PE, 2015/2016.

Cultivar / Origin	A. P. 1° cycle		A. P. 2° Cycle		DAF 1° Cycle		Cycle	
	C/C	S/C	C/C	S/C	C/C	S/C	C/C	S/C
BRS-Ponta Negra	250aA	182,5abB	242,5abcA	270abA	79,5aA	80aA	T	T
BRS-506	230abA	200abA	202,5bcA	222,5abA	51aB	79,5aA	P	M
13F02(1141570)	245aA	172,5abB	275abA	257,5abA	51aB	73aA	T	M
13F03(1141562)	197,5abA	192,5abA	270abA	267,5abA	51,5aA	68aA	P	M
13F04(1141572)	180abA	182,5abA	265abA	260abA	51,5aB	73aA	P	T
13F05(1140562)	180abA	137,5abA	200bcA	185abA	54aB	79aA	P	T
IPA 2502	137,5bA	125bA	130cA	170bA	79aA	69aA	T	T
IPA SF11	192abA	210abA	277,5abA	250abA	79aA	79aA	P	M
IPA SF15	240aA	225aA	302,5abA	292,5abA	80aA	78aA	P	P
IPA EP17	207abA	210abA	335aA	307,5aA	80,5aA	84aA	P	T
FEPAGRO-17	187,5abA	210abA	252,5abcA	245abA	80,5aA	50aA	P	M
FEPAGRO-190	222,5abA	225aA	190bcB	262,5abA	51aB	71aA	T	T
CV(%)	13,3		13,85		13,39		-	-
Pr>Fc	Cob x	0,32	0,656868		0.071927		-	-
	Cut.	0,0003	0,00003		0.000570		-	-
	Cob.	0,009	0.69236		0.000616		-	-

Averages followed by the same lowercase letter in the columns and uppercase letter in the rows do not differ by the Tukey test at 5% probability. Cut.= cultivar; Cob.= Cover; C/C= with cover; S/C= without cover; DAF= days to flowering; T= late cycle; M= medium cycle; P= early cycle; CV(%)= coefficient of variation. Source: Authors (2023).

Evaluating the crop's productivity in the 1st cycle, SF190 stands out for having approximately 14% more Green Mass ($41.30 \text{ t} \cdot \text{ha}^{-1} \text{ MV}$) and Dry Mass ($14.45 \text{ t} \cdot \text{ha}^{-1} \text{ MS}$) in the S/C cultivation condition (Figures 2 A and B). This is a rare occurrence as, theoretically, plants grown in soil without mulch are more vulnerable to bad weather, mainly due to the lower availability of soil moisture and the higher temperature in the root zone. These factors can induce lower nutrient absorption, lower plant development, and, consequently, lower productivity.

Figure 2 - Average green mass (A) and dry mass (B) values of different sorghum cultivars, sown under different growing conditions. Serra Talhada, PE. 2015/2016.



Averages followed by the same lowercase letter do not differ for the cultivars factor within growing conditions and averages followed by the same uppercase letter do not differ for growing conditions within cultivars, according to Tukey's test at 5% probability.

1st cycle. Pr>F_c values: cultivars = 0.0003, cover = 0.009, interaction = 0.32. CV=13.3%.

2nd Cycle. Pr>F_c values: cultivars = 0.00003, cover = 0.6923, interaction = 0.6568. CV=13.85%.

Source: Authors (2023).

The results obtained in the 1st cycle of this experiment for PMV and PMS, which reached 52.80 t.ha⁻¹ and 18.51 t.ha⁻¹, respectively, are higher than the values observed by Costa et al., (2015), evaluating forage sorghum and dual-purpose cultivars in the same environment and agricultural year, found values of up to 44.02 t.ha⁻¹ and also higher than those of Perazzo et al., (2013) who assessed the performance of 14 forage sorghum genotypes in the Brazilian semi-arid region and found values of up to 48.50 t.ha⁻¹.

About SMP (Figure 2 B), five of the 12 cultivars showed values between 9.20 t.ha⁻¹ and 18.50 t.ha⁻¹, considered to be good and excellent productivity indices, especially for the soil and climate conditions in which they were grown.

In this sense, it is important to seek answers to this behavior, after all, the study was carried out in conditions considered adverse for most cultivated plants, such as cultivation outside the agricultural calendar and the quality of the water supplied to the plants.

Thus, two of the other possibilities to explain the results of this study can be attributed to the studies by Luna et al., (2018) "Because it has a C4 metabolism, it can withstand environments with high temperatures and limited water and is exceptionally efficient at using solar radiation, water and nitrogen". The second can be attributed to the studies by Appiah-Nkansah et al., (2019), who pointed out that real productivity in any region is a function of climatic conditions, soil type, and agronomic practices.

Therefore, taking into account that mulching translates into benefits such as preventing the incidence of light from transferring heat directly to the soil, maintaining its moisture for longer, minimizing the temperature in the root environment and, therefore, evapotranspiration, as well as reducing the emergence of weeds that can compete with the crop for water, light, and

nutrients, in addition to not allowing the impact of raindrops directly on the soil, preserving and/or improving its structure.

Thus, it is worth noting that these factors contribute directly or indirectly to keeping the soil solution in favorable conditions of water and nutrient availability for the crop. This is different from the treatment with no cover crops (S/C).

Based on this principle, figure 2 also highlights the superior behavior of 5 of the 12 genetic materials under study (IPA SF 15; FEPAGRO 190; BRS Ponta Negra; IPA SF 11 and EP 17), showing yields of over 30 t.ha⁻¹ of MV and between 9.38 and 18.50 t.ha⁻¹ of DM, in the two cropping systems (C/C and S/C). When the differences in yields between the two cropping conditions were analyzed, the percentages ranged from 40.97% (EP17) to 6.14% (2502).

In this scenario, it is important to highlight the superiority of IPA SF-15 which, even under adverse conditions, showed yields of 52.80 and 40.60 t.ha⁻¹ of MV and 18.51 and 14.21 t.ha⁻¹ of DM under C/C and S/C conditions, respectively Figures 2 (A and B).

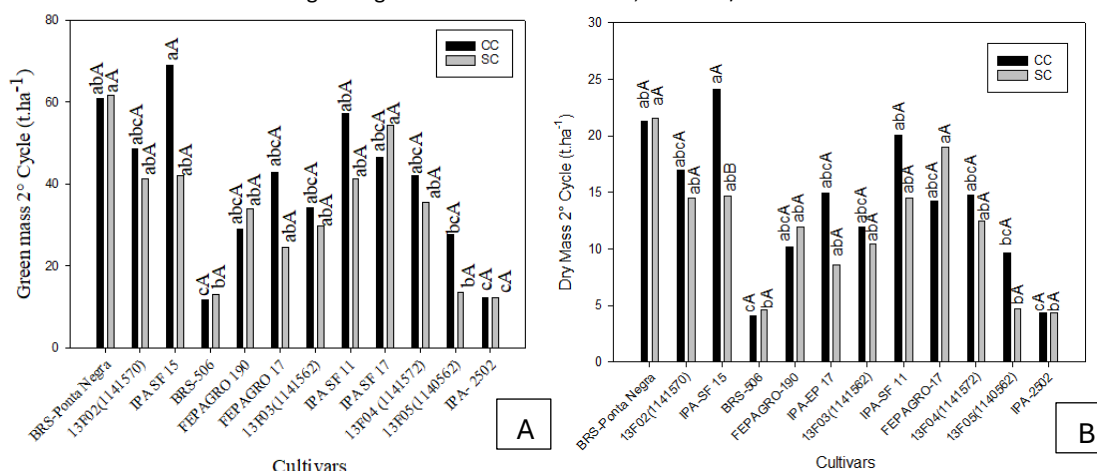
These results indicate that some of the cultivars evaluated, when subjected to the C/C system, showed excellent yields, even outside the agricultural calendar, which is considered to be of great importance for semi-arid regions in terms of providing quality fodder during the least favorable period for livestock feed.

Another relevant fact that may have contributed to the superior performance of these materials can be attributed both to their adaptability to the semi-arid environment and to the climatic factors highlighted in this study, such as the air temperature, which did not reach 30°C, and global solar radiation of around 25 Mj.m⁻² (Figure 1).

These are two relevant climatic factors for sorghum, which has a C4 metabolism and also has a waxy layer on the stems and leaves which, in the presence of temperatures above 30°C, allows it to better control stomata activity, favoring respiration and transpiration processes.

Evaluating the behavior of sorghum in the 2nd cycle, it is possible to see average yields of up to 68.85 t.ha⁻¹ of MV and 24.10 t.ha⁻¹ of DM represented by (SF15) in the C/C condition. On the other hand, the materials SF17; SF190; 506, and PN stand out for having higher yields in the S/C cultivation condition, compared to the C/C Figures 3 (A and B).

Figure 3: Average values of green mass (A) and dry mass (B) of the second cycle of different sorghum cultivars in two growing conditions. Serra Talhada, PE. 2015/2016.



Averages followed by the same lowercase letter do not differ for the cultivars factor within growing conditions and averages followed by the same uppercase letter do not differ for growing conditions within cultivars, according to Tukey's test at 5% probability.

1st cycle. Pr>F_c values: cultivars = 0.00001, cover = 0.00001, interaction = 0.575. CV=30.30%.

2nd cycle. Pr>F_c values: cultivars = 0.00001, cover = 0.05514, interaction = 0.57486. CV=30.31%.

Source: Authors (2023).

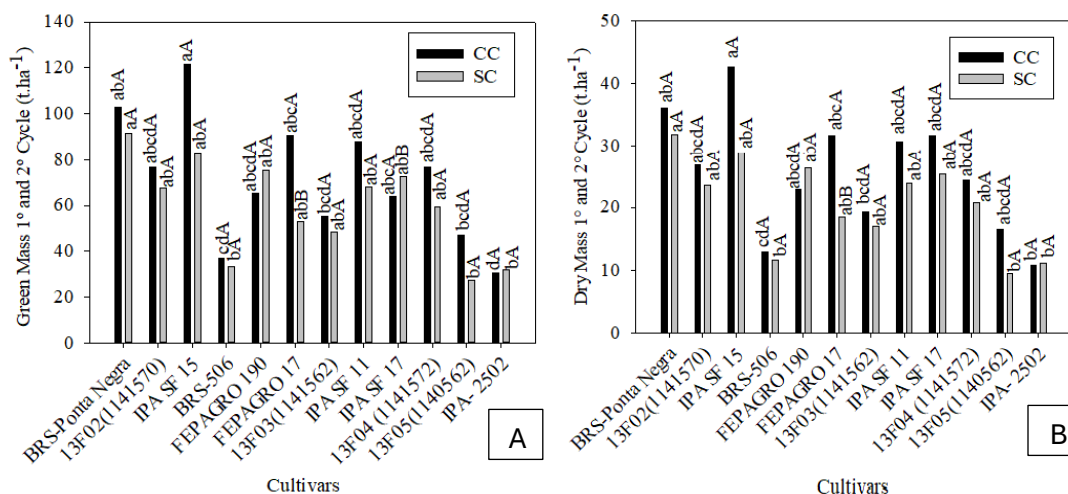
Once again, we need to look for answers, because as was already pointed out in the discussion about the first cycle of this study, the S/C cultivation condition would theoretically be less favorable than the C/C condition. Furthermore, it is important to note that the literature highlights a decrease in productivity from the second sorghum cycle onwards.

Simplicio et al., (2019) evaluating 10 forage sorghum materials in the semi-arid region of Alagoas over four consecutive cycles observed decreases of up to 110% between the 3rd and 4th cycles. They concluded that as a result of the stresses suffered, mainly by the cycle and then by the number of tillers issued by the plants, there is competition for water, nutrients, and light, due to the increase in the crop's population, hindering development with a consequent reduction in productivity.

Elias et al., (2016) evaluated four sorghum materials in a no-till system in the Sertão do Pajeú (semi-arid region of Pernambuco), with only 73.4 mm of rain in the cycle, and found yields of up to 20.77 t.ha⁻¹ of MV and up to 6.05 t.ha⁻¹ of DM.

These results reinforce the studies already consolidated by the no-till straw system, pointing out that mulching maintains soil moisture, among other benefits, favoring plant development, and can also add to the water use efficiency characteristics of the sorghum crop. When the averages of the two cycles (plant + regrowth) were taken into account, there were yields of up to 121.74 t.ha⁻¹ and 42.61 t.ha⁻¹ of DM and DM, respectively, in the C/C system, represented by SF15, and 91.30 and 31.96 t.ha⁻¹ of DM and DM, respectively, in the S/C system, represented by PN Figures 4 (A and B).

Figure 4 - Average values of green mass (A) and dry mass (B) of the first and second cycles of different sorghum cultivars in two growing conditions. Serra Talhada, PE. 2015/2016.



Averages followed by the same lowercase letter do not differ for the cultivars factor within growing conditions and averages followed by the same uppercase letter do not differ for growing conditions within cultivars, according to Tukey's test at 5% probability.

1st cycle. Pr>F_c values: cultivars = 0.00001, cover = 0.02047, interaction = 0.5045. CV=24.68%.

2nd cycle. Pr>F_c values: cultivars = 0.00001, cover = 0.02045, interaction = 0.50441. CV=24.68%.

Source: Authors (2023).

When looking at the range of yields between the sorghum genetic materials by cropping system in the two harvests, there were values between 30.65 and 121.75 t.ha⁻¹ DM and 42.61 and 10.73 t.ha⁻¹ DM, which represented approximately 297% respectively, when subjected to the C/C treatment. In the S/C treatment, yields ranged from 91.30 to 27.30 t.ha⁻¹ DM and 31.96 to 9.55 t.ha⁻¹ DM, representing approximately 234% respectively.

Combining the studies with the simulation carried out to measure the temperatures in the experiment's environment, as shown in the images (A to F) in Figure 4, the results observed allow us to conclude that the C/C system increased sorghum productivity by up to 297%, even in the presence of water of up to 1.4 dS.m⁻¹ throughout the cycle and high T^oC, which ranged from 29°C in the covered soil (C/C) to 60°C in the soil exposed to the weather.

Figures 4 (A to F). T^oC on the soil surface without mulch (A); T^oC on the mulch (B); T^oC on the leaf surface (C); T^oC on vegetated saline ebb soil (D); T^oC on saline ebb soil (E) and T^oC 10 cm from the surface in saline ebb soil (F). Serra Talhada, PE.



Source: Simpício, J.B., 2016.

One fact worth noting is the inversion of the MV and DM yields of SF15 and PN in the two cultivation systems (C/C and S/C), where SF15 produced an average of 18.26% more MV and DM than PN in the C/C system. On the other hand, PN produced an average of 10.53% more MV and DM than SF15 in the S/C system, indicating greater efficiency in the use of water to produce DM per area, even in more adverse conditions.

This behavior deserves to be highlighted, given that the C/C system allows for greater thermal comfort for the soil solution, favoring the absorption of water and nutrients by the plants, to the detriment of the S/C condition, as can be seen in the productivity indices reported in this study and in the images in Figure 4 (A to F).

This highlights the importance of studies on lowland soils and the use of mulch as a precursor to better clarification when less favorable results are reported when comparing different crops (C/C and S/C) in semi-arid conditions.

Because both fallow cultivation and the use of mulch are reported to be positive factors, such as the accumulation of organic matter and the maintenance of soil humidity, they allow for the dilution of sodium salts, enabling better development of forage sorghum genetic materials, evaluated under stress with saline water and higher temperatures.

Such studies are necessary, even though sorghum is already considered to be tolerant of water deficit due to its highly branched root system, with greater power to explore the soil, wax coating the leaves and stalks, and a greater number of stomata when compared to maize and other plants from the Poaceae family, for example.

Perazzo et al., (2013), evaluating different sorghum cultivars in the semi-arid region of Paraíba, identified yields for the IPA 2502 cultivar of 11.80t.ha⁻¹ of DM, with nitrogen fertilization of 100 Kg.ha⁻¹ and rainfall of 115 mm during cultivation, emphasizing that sorghum generally goes into periods of dormancy or vegetative rest during summers and starts growing again when water is available.

In another study, Costa et al. (2015) found 10.29 t.ha⁻¹ for IPA 2502 in the semi-arid region of Pernambuco, in fall cultivation, with 91 kg of N and 117 kg of K₂O ha⁻¹.

In this context, Okumura et al., (2011) point out that, in addition to the effect on productivity, nitrogen interferes with various other plant characteristics related to growth and development, which directly or indirectly affect crop productivity.

Although in other studies it has stood out for its importance as it can be used for dual purposes (grain and fodder), in this study, the SF 2502 sorghum variety proved to be less promising than the others with an average of only 30.65 and 10.73 t.ha⁻¹ of DM and DM in the C/C system and 31.40 and 11.16 t.ha⁻¹ of DM and DM in the S/C system, respectively.

Further studies are therefore suggested to assess the agronomic performance of the SF 2502 variety under less favorable growing conditions to observe possible soil and climate factors that could negatively influence its development.

4 CONCLUSIONS

Under the conditions in which the studies were carried out, it was possible to conclude that:

- 1.) The cover cropping system (C/C) allowed for better yields of up to 30% in the 1st cycle and up to 64% in the 2nd cycle among the systems studied.
- 2.) The 2nd cycle was favored by rainfall, which provided yields of up to 68.85 and 61.6 t.ha⁻¹ MV and 24.10 and 21.56 t.ha⁻¹ MS, respectively, in the two growing conditions C/C and S/C.
- 3.) The IPA SF 15 and BRS Ponta Negra varieties were responsible for the highest yields, with rates of over 120 and 100 t.ha⁻¹ DM (C/C) and 86 and 90 t.ha⁻¹ DM (S/C), respectively.
- 4.) In the 1st and 2nd cycles, the S/C cultivation system provided the highest yields for the IPA SF17, IPA 2502 and FEPAGRO 190 varieties, respectively.

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