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Agrotechnological characteristics of sugarcane cultivars irrigated with salinized water[1]

Características agrotecnológicas de cultivares de cana-de-açúcar irrigadas com água salinizada

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HIGHLIGHTS:
Culm mass per clump in sugarcane is reduced under irrigation water electrical conductivity of 4.6 dS m⁻¹.
The number of tillers is not influenced by irrigation water electrical conductivity up to 4.6 dS m⁻¹.
A sugarcane cultivar RB 92 579 tem qualidade industrial superior a SP 81 3250.

ABSTRACT: With the expansion of sugarcane cultivation in the semiarid region of Brazil, there is a constant risk of soil salinization because of the edaphoclimatic peculiarities of the region, requiring studies to identify genotypes tolerant to salt stress. This study evaluated the agrotechnological characteristics of sugarcane cultivars irrigated with salinized water. This study was performed in the experimental area of the Academic Unit of Agricultural Engineering of the Federal University of Campina Grande, Paraíba, Brazil. The treatments consisted of a combination of two sugarcane cultivars (SP 81 3250 and RB 92 579) and five levels of electrical conductivity of irrigation water (0.6, 1.6, 2.6, 3.6, and 4.6 dS m^{-1}). A randomized block design was used in a 2 × 5 factorial scheme with four replicates, totaling 40 experimental units. The sugarcane cultivar SP 81 3250 under irrigation with saline water of 0.6, 1.6, and 2.6 dS m^{-1} promoted a greater number of leaves in relation to RB 92 579, 125 days after planting. The salinity of the irrigation water varying from 0.6 to 4.6 dS m^{-1} reduces the culm height and culm mass per clump of the sugarcane, regardless of the cultivar. The sugarcane cultivar RB 92 579 had the highest culm height, number of tillers, culm mass per clump, percentage of apparent sugars, soluble solids, polarized sucrose, and total recoverable sugars, whereas SP 81 3250 had the highest percentage of water-insoluble matter contained in the cane, regardless of water salinity.

Key words: *Saccharum* ssp., salt stress, industrial quality

RESUMO: Com a expansão do cultivo da cana-de-açúcar no semiárido brasileiro, há o risco constante de salinização do solo, devido as peculiaridades edafoclimáticas da região, o que tem demandado estudos para identificar genótipos tolerantes ao estresse salino. Nesse sentido, objetivou-se avaliar as características agrotecnológicas de cultivares de cana-de-açúcar irrigadas com água salinizada. O estudo foi realizado na área experimental da Unidade Acadêmica de Engenharia Agrícola da Universidade Federal de Campina Grande, Paraíba, Brasil. Os tratamentos consistiram a partir da combinação de duas cultivares de cana-de-açúcar (SP 81 3250 e RB 92 579) e cinco níveis de condutividade elétrica da água de irrigação (0,6; 1,6; 2,6; 3,6 e 4,6 dS m^{-1}). Utilizou-se o delineamento experimental de blocos casualizados, em esquema fatorial 2 × 5 com quatro repetições, totalizando 40 unidades experimentais. A cana-de-áçúcar cultivar SP 81 3250 sob irrigação com água salina de 0.6, 1.6 e 2.6 dS m^{-1} obtém maior numero de folhas em relação a RB 92 579, aos 125 dias após o plantio. A salinidade da água de irrigação variando de 0.6 a 4.6 dS m^{-1} reduz a altura do colmo e a massa de colmo por touceira da cana-de-açúcar, independente da cultivar. A cana-de-áçucar cultivar RB 92 579 detem maior altura do colmo, número de perfilhos, massa de colmo por touceira, porcentagem de açúcares aparente, sólidos solúveis totais, sacarose polarizada e açúcares totais recuperáveis, enquanto SP 81 3250 teve a maior porcentagem de matéria insolúvel em água contida na cana, independente da salinidade.

Palavras-chave: *Saccharum* spp., estresse salino, qualidade industrial

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Introduction

In the global climate change scenario, water scarcity has become increasingly frequent in arid and semi-arid regions of the planet in quantity and quality, with impacts on agricultural soils and socio-economic development (Hopmans et al., 2021).

Sugarcane is an important commodity for agribusiness, and in addition to the large-scale production of ethanol and sugar, it is used for various purposes, such as vinasse, filter cake, and bagasse, which are used in animal feed, fertilizers, and energy production (Chiconato et al., 2019, 2021; Elsheery et al., 2020). However, in most producing states in the northeast, the climate is predominantly semi-arid, requiring irrigation with water of high salinity (Medeiros et al., 2016).

Under such conditions, plants undergo morphological, physiological, and biochemical changes due to the disruption of homeostasis in plant water potential, specific ion toxicity, and nutritional imbalance, with a reduction in growth, development, and yield (Munns & Gilliham, 2015; Lira et al., 2018; Simões et al., 2019).

Sugarcane is a plant considered moderately tolerant to salinity, with a threshold water salinity of 1.1 dS m^{-1}. Its yield reduction can reach 50% in soils with a saturation extract electrical conductivity of 10.4 dS m^{-1} and in water with salt contents corresponding to 6.8 dS m^{-1} (Ayers & Westcot, 1999; Santana et al., 2007). In this context, it is important to evaluate the development of sugarcane under saline conditions, making it possible to expand its cultivation in regions with such problems, mainly in semiarid regions. This study aimed to evaluate the agrotechnological characteristics of sugarcane cultivars irrigated with salinized water.

Material and Methods

The study was conducted between December 2011 and October 2012 in an experimental area of the Academic Unit of Agricultural Engineering (UAEA) of the Federal University of Campina Grande (UFCG), located in the municipality of Campina Grande, Paraíba, Brazil, at the geographical coordinates 7° 15' 18" S, 35° 52' 28" W and an average altitude of 550 m.

The climatic data recorded during the experimental period are shown in Figure 1.

The treatments consisted of a combination of two factors: two sugarcane cultivars (SP 81 3250 and RB 92 579), and five levels of electrical conductivity of irrigation water (ECw: 0.6, 1.6, 2.6, 3.6, and 4.6 dS m^{-1}). The electrical conductivity of 0.6 dS m^{-1} corresponded to the local water supply as control treatment, and the other salinity levels were based on the threshold water salinity of the sugarcane (1.1 dS m^{-1}) (Ayers & Westcot, 1999). The design was in randomized blocks in a 2 × 5 factorial scheme with four replicates, totaling 40 experimental plots composed of four clumps per lysimeter.

Soil material was obtained from the District of São José da Mata (Campina Grande, PB) and classified as Ultisol. Before the start of the experiment, soil samples were collected at a depth of 0-20 cm to analyze the chemical and physical attributes, the values of which are listed in Table 1.

The experiment was installed in drainage lysimeters with 1.5 m length, 1.0 m width, and 1.0 m depth, containing at the bottom a 10 cm layer of gravel and another of sand to contain the soil and facilitate drainage. The lysimeters were then filled with sandy loam soil. Figure 2 shows a view of the experiment with all lysimeters.

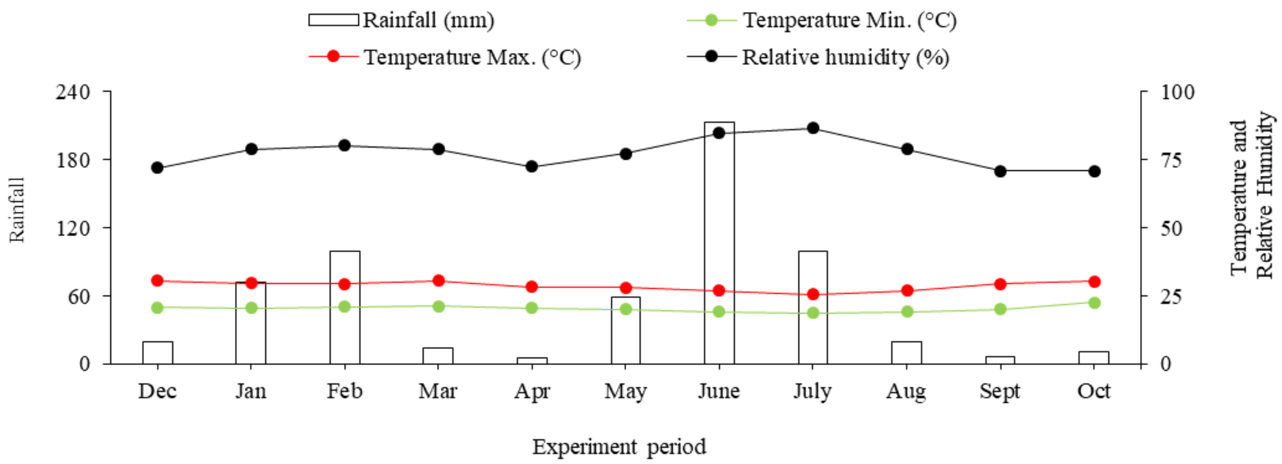


Figure 1. Climatic data recorded during the experimental period from December 2011 to October 2012

Table 1. Chemical attributes of the soil material used in the experiment

pH	P (mg dm^{-3})	K	Ca	Na	Mg	Al	H + Al	SB	CEC	OM (g dm^{-3})	ECse (dS m^{-1})	ESP
		($cmol_c$ dm^{-3})										
6.53	47.7	0.17	2.21	0.05	1.85	0	0.44	4.28	4.72	8.90	0.06	1.17

Physical attributes			
Sand	Silt	Clay	Soil density
	(g dm^{-3})		(kg dm^{-3})
733	84	183	1.60

pH H_2O (1:2.5), hydrogen potential; OM, organic matter; ECse, electrical conductivity of the saturated extract; CEC, cation exchange capacity at pH 7.0; ESP, exchangeable sodium percentage

Figure 2. View of the experiment with all lysimeters

Culms were obtained from the Central Olho d'Água Plant, located in the municipality of Camutanga, PE (latitude: 7º 25' 07" S, longitude: 35° 16' 35" W, altitude 109 m). The lysimeters were saturated for 24 h, and then the drains were opened to drain excess water until the soil reached the field capacity. The crop was then planted. Irrigation was conducted daily based on the water balance (Bernardo et al., 2006), using Eq. 1.

$$Lw = (I - D) \times (Fc \times Kc) + D \quad (1)$$

where:

Lw - water depth to be applied, mm;
I - irrigation depth, mm;
D - volume drained, mm;
Fc - correction factor, 50% of the Kc, dimensionless; and
Kc - crop coefficient varying according to the phenological phase, dimensionless.

The experiment was divided into two stages based on the application of salinity treatments through irrigation. In the first stage, from 23/12/2011 to 06/03/2012, in irrigation, low electrical conductivity water (local supply system) was used until the beginning of the emergence of the first sprouts, 12 days after planting (DAP).

Irrigation was performed every two days, and when the crop completed 56 DAP, irrigation was performed every three days. After 80 DAP, the second experimental stage began with the application of saline water treatments, with irrigation every three days, and was suspended on days with rainfall greater than 5 mm per day.

The saline waters were prepared by dissolving the salts $NaCl$, $CaCl_2.2H_2O$, and $MgCl_2.6H_2O$, in equivalent proportions of 7:2:1, respectively, in the local municipal supply water (ECw = 0.4 dS m^{-1}) according to Richards (1954), whose quantity of salts was determined by Eq. 2. This proportion of salts is commonly found in water sources used for irrigation, with small properties in the Brazilian northeast (Medeiros, 1992).

$$Q = 640 \times ECw \quad (2)$$

where:

Q - quantity of salts (mg L^{-1}); and,
ECw - electrical conductivity of the water (dS m^{-1}).

For each irrigation, water with different salinity levels was prepared in plastic boxes using an electrical conductivity meter to measure and control electrical conductivity, and the volume of water leached through the drains connected to each lysimeter was collected every two days.

Fertilization was adopted according to the recommendations of Alvarez et al. (1991), with P_2O_5 and K_2O at planting, in the amounts corresponding to 180 and 100 kg ha^{-1}, respectively. After 60 days, 100 kg ha^{-1} of K_2O and 90 kg ha^{-1} of N were applied; nitrogen fertilization was repeated in three more applications of 45 kg ha^{-1} of N, in March, May, and August, coinciding with the last two nitrogen fertilization applications, with 100 kg ha^{-1} of K_2O in each application.

After the beginning of salt application, the following variables were evaluated monthly: culm height (CH), number of leaves (NL), and number of tillers (NT) per clump. Culm height was measured from the ground to the top visible dewlap leaf (leaf +1) (Leanasawat et al., 2021), starting at 95 DAP and ending at 275 DAP.

The culm mass per clump (CMC) was evaluated at the end of the cycle by cutting the stalks at the base, close to the ground, removing the dry leaves, and eliminating the apical meristems. The culms were sent to the Laboratory of Miriri Alimentos e Bioenergia S.A. for technological analysis [percentage of apparent sugars (PAS - %), soluble solids (SS - °Brix), polarized sucrose (Pol), percentage of water-insoluble matter contained in sugarcane (Fiber - %), juice purity (JP - %), and total recoverable sugars (TRS - kg t^{-1})].

Data were submitted to the normality and homogeneity test (Kolmogorov-Smirnov), followed by the analysis of variance (ANOVA). The F test was applied to the cultivars ($p \leq 0.05$), and the levels of electrical conductivity of the irrigation water (ECw) were analyzed by polynomial regression using the Sisvar program (Ferreira, 2019).

Results and Discussion

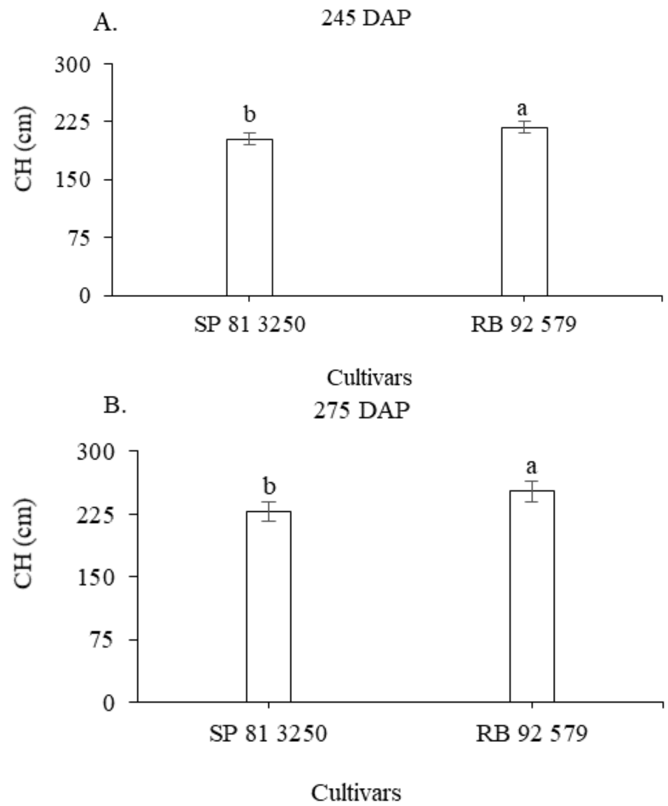
Considering that it is more important to discuss the effect of interaction when significant, emphasis was given to the C × ECw interaction on the number of leaves (NL) at 125 DAP (Table 2). There was a significant effect of the cultivars on the mean plant culm height (CH) and the number of tillers (NT) at 245 and 275 DAP, whereas, for the NL, there was a significant effect at 125 and 155 DAP. For the water salinity factor, a significant effect was recorded for CH on all dates; however, for the NL, only at 275 DAP (Table 2). There was also a significant effect of blocks on CH 95 and 125 DAP, NL 95, 125, and 245 DAP, and NL at 95, 185, and 275 DAP, demonstrating the importance of maintaining the error within each block.

The highest culm plant height was obtained in RB 92 579 at 245 and 275 DAP, with an increase of 6.87 and 9.5%, respectively, compared to SP 81 3250 (Figures 3A and B). The difference between cultivars may be genetic because genotypes of the same species can develop differently owing to varietal characteristics and environmental conditions (Dutra Filho et al., 2021). A study by Capone et al. (2011) observed that cane stature was influenced by the genetic potential of the genotypes when evaluating the behavior of 15 sugarcane cultivars in the southern region of Tocantins.

Table 2. Summary of the analysis of variance for culm height (CH), number of leaves (NL), and number of tillers (NT) of sugarcane cultivars under irrigation water salinity at 95, 125, 155, 185, 215, 245, and 275 days after planting (DAP)

Sources of variation	DF	Mean squares						
		95 DAP	125 DAP	155 DAP	185 DAP	215 DAP	245 DAP	275 DAP
					Culm height			
Cultivars (C)	1	72.29^{ns}	93.09^{ns}	24.40^{ns}	4.57^{ns}	1196.78^{ns}	2232.22*	5805.75**
Salinity (ECw)	4	103.62**	1111.42**	1678.18**	1873.65**	2128.14**	2551.69**	5617.98**
Linear	1	252.17**	4210.33**	6091.20**	6979.87**	8071.27**	9852.08**	21418.83**
Quadratic	1	38.93^{ns}	211.70^{ns}	495.42^{ns}	393.67^{ns}	294.21^{ns}	268.15^{ns}	689.53^{ns}
C × ECw	4	34.42^{ns}	41.52^{ns}	115.28^{ns}	355.33^{ns}	173.42^{ns}	157.66^{ns}	548.55^{ns}
Block	3	107.95*	557.03*	276.59^{ns}	212.34^{ns}	449.23^{ns}	765.56^{ns}	969.39^{ns}
Residue	27	27.14	154.66	363.09	305.84	368.92	439.85	680.10
CV (%)	-	12.82	15.20	17.02	11.67	10.90	9.99	10.85
					Number of Leaves			
Cultivars (C)	1	1.534^{ns}	2.459*	1.516**	0.977^{ns}	0.590^{ns}	0.144^{ns}	0.417^{ns}
Salinity (ECw)	4	0.111^{ns}	0.843^{ns}	0.065^{ns}	0.388^{ns}	0.060^{ns}	0.589^{ns}	1.949**
Linear	1	0.585^{ns}	2.460*	0.002^{ns}	0.007^{ns}	0.198^{ns}	1.911^{ns}	7.411**
Quadratic	1	0.001^{ns}	0.812^{ns}	0.071^{ns}	0.914^{ns}	0.001^{ns}	0.056^{ns}	0.203^{ns}
C × ECw	4	0.413^{ns}	0.919*	0.409^{ns}	0.713^{ns}	0.342^{ns}	0.314^{ns}	0.438^{ns}
Block	3	3.494*	2.133**	0.822^{ns}	1.391^{ns}	0.960^{ns}	1.296*	1.033^{ns}
Residue	27	0.673	0.334	0.343	0.502	0.388	0.406	0.382
CV (%)	-	8.81	5.94	6.30	7.74	7.44	7.84	7.47
					Number of tillers			
Cultivars (C)	1	0.025^{ns}	0.065^{ns}	0.064^{ns}	0.076^{ns}	0.338^{ns}	0.392*	0.295*
Salinity (ECw)	4	0.086^{ns}	0.038^{ns}	0.034^{ns}	0.0169^{ns}	0.013^{ns}	0.010^{ns}	0.033^{ns}
Linear	1	0.010^{ns}	0.023^{ns}	0.006^{ns}	0.299^{ns}	0.051^{ns}	0.021^{ns}	0.066^{ns}
Quadratic	1	0.002^{ns}	0.012^{ns}	0.005^{ns}	0.006^{ns}	0.001^{ns}	0.003^{ns}	0.035^{ns}
C × ECw	4	0.081^{ns}	0.127^{ns}	0.0892^{ns}	0.057^{ns}	0.024^{ns}	0.031^{ns}	0.041^{ns}
Block	3	1.044**	0.313^{ns}	1.153^{ns}	0.167*	0.212^{ns}	0.136^{ns}	0.183*
Residue	27	0.143	0.111	0.069	0.048	0.084	0.059	0.059
CV (%)	-	9.60	7.66	6.48	6.15	6.15	8.41	8.58

DF - Degrees of freedom; CV - Coefficient of variation. ^{ns} - Not significant, * - significant at 0.05, and ** - significant at 0.01 probability level by the F test



Means followed by the same letters indicate no significant differences between them in the F-test ($p \leq 0.05$). Vertical bars indicate the standard error of the mean (n=4)

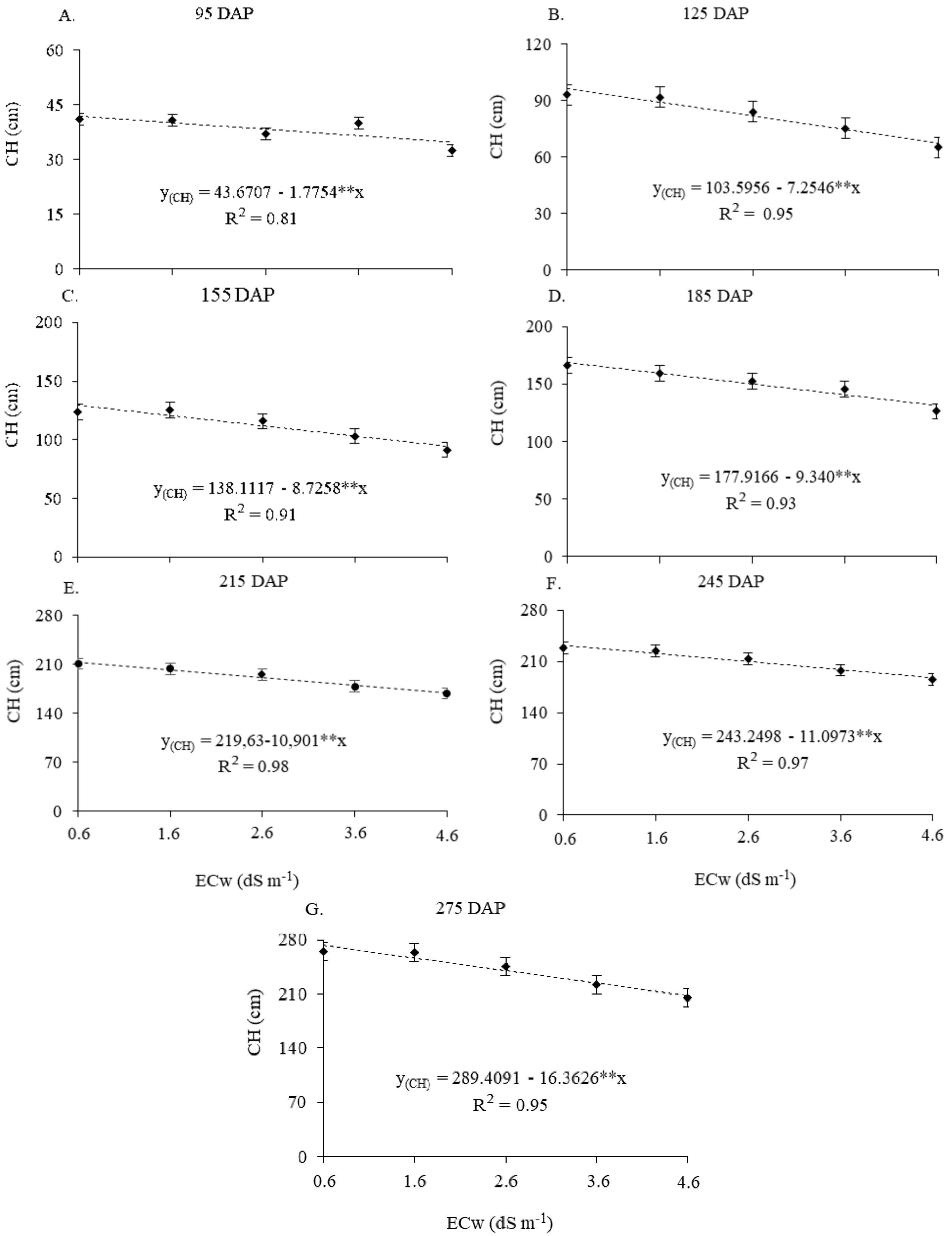
Figure 3. Culm height (CH) of sugarcane cultivars, 245 (A) and 275 (B) days after planting

For the salinity factor, in all evaluations, the effect on average culm height decreased linearly (Figure 4). When comparing the highest saline level with the lowest, there was a reduction in culm height of 16.60, 29.23, 26.26, 21.68, 20.46, 18.76, and 23.40% at 95, 125, 155, 185, 215, 245, and 275 DAP, respectively (Figure 4A, B, C, D, E, F, and G). The results can be explained by the fact that, by increasing the salt concentration in the soil, a reduction in the osmotic potential occurs; therefore, the plant is unable to absorb water due to the reduction in the water potential of the soil (Zahra et al., 2020).

Zhao et al. (2020), when evaluating sugarcane growth under salinity of irrigation water during tillering and elongation, found reductions in plant height of 13.5, 11.1, 18.3, and 31%, respectively, for saline levels of 38, 75, 150, and 300 mM. In addition, Lira et al. (2018) evaluated the growth of sugarcane irrigated with brackish water and leaching fractions and found that salinity negatively affected plant stature.

According to Dias et al. (2016), excess soluble salts in the soil solution cause changes in cellular metabolism, affecting the primary carbon metabolism, elongation, and elasticity of the cell wall; thus, plant growth is impaired, which explains the reduction in thatch stature. In addition, under such stress, there is a reduction in the transport of Na^+ and Cl^- ions in the xylem and greater energy expenditure to maximize water uptake from the soil (Munns & Gilliham, 2015).

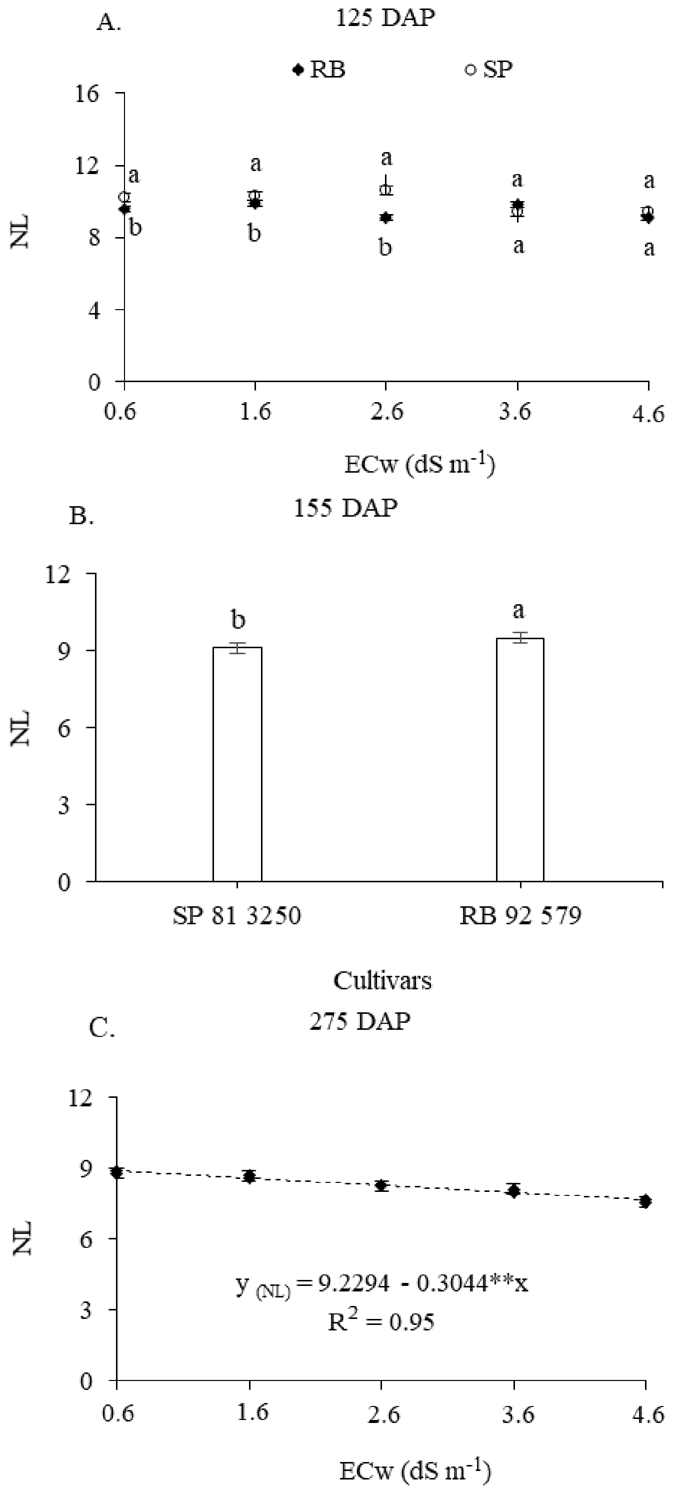
The interaction between cultivar (C) × salinity of irrigation water (ECw) at 125 DAP (Figure 5A) showed a reduction of 2.3% per unit increase in ECw for cultivar SP 81 3250, although there was no satisfactory adjustment (y = 10.633 - 0.2493*x, R^2 = 0.51) for prognostic purposes. For the RB 92 579 plants, the data also did not obtain satisfactory adjustment (y = 9.7526 - 01015*x, R^2 = 0.19), with an average of 9.5 leaves. When splitting the cultivars within each saline level, a greater



** - Significant at p ≤ 0.01 by F test. Vertical bars indicate the standard error of the mean (n=4)

Figure 4. Culm heigth (CH) of sugarcane as a function of electrical conductivity of irrigation water (ECw) at 95 (A), 125 (B), 155 (C), 185 (D), 215 (E), 245 (F), and 275 (G) days after planting

number of leaves were observed in SP 81 3250 at saline levels of 0.6, 1.6, and 2.6 dS m^{-1}. For saline levels of 3.6 and 4.6 dS m^{-1}, there was no significant difference (p>0.05) between cultivars (Figure 5A).



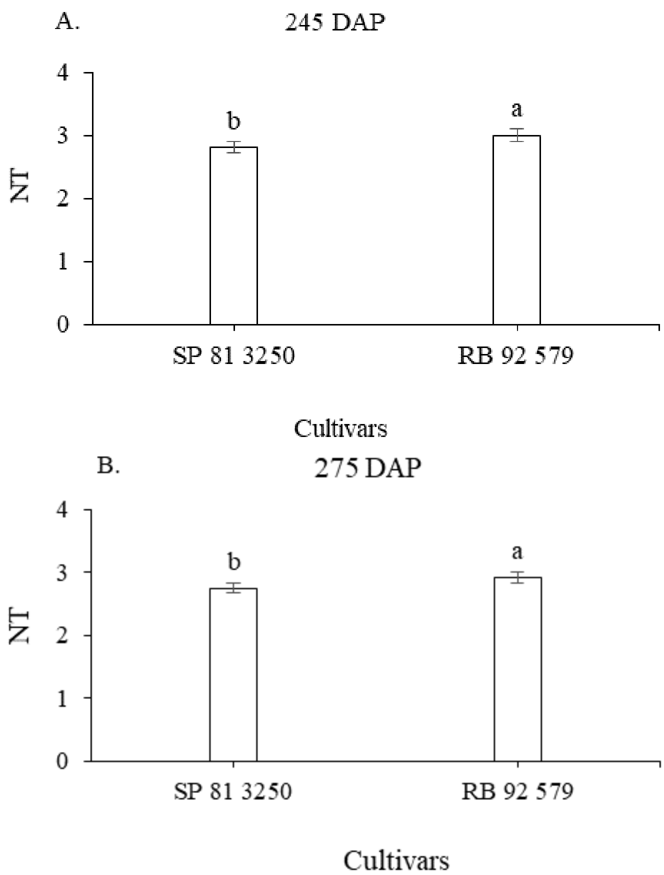
** - Significant at p ≤ 0.01 by F test. Means followed by the same letter indicate no significant difference between them by the F test at p ≤ 0.05. Vertical bars indicate the standard error of the mean (n=4)

Figure 5. (A) Number of leaves (NL) of sugarcane, as a function of electrical conductivity of irrigation water (ECw), 125 (A) and 275 (C) days after planting (DAP) as a function of electrical conductivity of irrigation water (ECw) and as a function of cultivars, 275 DAP (C)

At 155 DAP, the number of leaves was influenced only by the cultivars, observed in RB 92 579 with greater NL (9.49) than in SP 81 3250 (9.10) (Figure 5B). In the last evaluation, 275 DAP (Figure 5C), there was a negative linear effect on the level of irrigation water salinity. According to the mathematical model, there was a 3.3% decrease in NL per unit increase in the ECw. According to Dias et al. (2016), the osmotic effect induces water deficiency in plants, and morphological and anatomical changes may occur, especially in the leaves, as an alternative to reduce transpiration and maintain tissue hydration. Oliveira et al. (2007), studying leaf area in three sugarcane cultivars and its correlation with biomass production on dystrophic Red Latosol in the state of Paraná, found that RB 72 454 and RB 85 5113 had the greatest number of leaves 377 DAP, and for RB 85 5536, the greatest number occurred 428 DAP.

The difference in the number of leaves between cultivars may be a genetic characteristic and adaptation of cultivars to the environmental conditions of the region where the experiment was conducted. Genotypes of the same species can respond differently to the effects of salt stress, as observed in a study performed by Brindha et al. (2019), when working with a few commercial sugarcane (Co 8021, Co 85019, Co 2001-13, Co 97010, Co 99004, Co 94012 Co 95007, and Co 97009) genotypes subjected to salinity stress at various growth phases of sugarcane. This is related to a greater capacity for osmotic adaptation, tolerance to higher ion concentrations, and the ability to maintain water uptake even under high salinity conditions (Munns et al., 2016).

For the number of tillers (Figures 6A and B), a significant effect between cultivars was recorded only in the last two evaluations (245 and 275 DAP). This observation is interesting because tillering in sugarcane is known to occur up to 120 DAP, and competition between tillers for water, light, space, and nutrients increases; consequently, many of the youngest



Means followed by the same letters indicate no significant differences between them in the F-test (p ≤ 0.05). Vertical bars indicate the standard error of the mean (n=4)

Figure 6. Number of tillers (NT) of sugarcane cultivars 245 (A) and 275 days after planting (B)

tillers die and the total number of culms is reduced (Manhães et al., 2015).

In addition to the greater culm height and number of leaves, sugarcane cultivar RB 92 579 had a greater number of tillers. All these data are reflected directly in the thatch weight of the sugarcane plants and the technological indices.

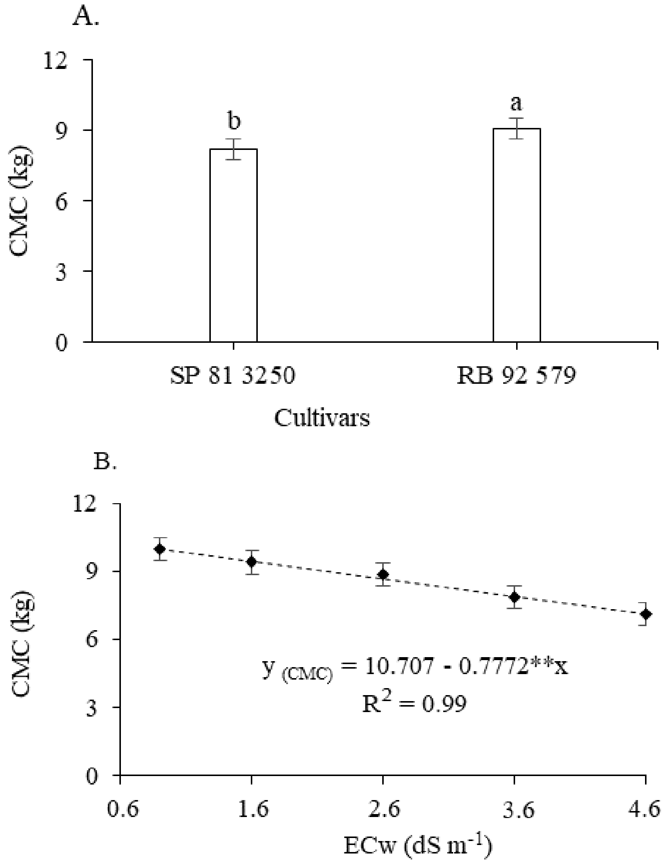
The cultivar factor had a significant effect on the culm mass per clump (CMC), percentage of apparent sugars (PAS), soluble solids (SS), polarized sucrose (Pol), percentage of water-insoluble matter contained in the cane (fiber), and total recoverable sugars (TRS). However, no significant effect of cultivar on juice purity was observed. Only the weight of the thatch per clump was significantly affected by the water salinity factor. There was no significant interaction between the factors for yield or technology index variables (Table 3).

As shown in Figure 7A, a higher CMC (10.38 %) was recorded in RB 92 579 (9.070 kg) relative to SP 81 3250 (8.217 kg). The increase in NT and CH of cultivar RB 92 579 may have provided a greater mass of stem per clump.

When irrigated with salinized water (4.6 dS m^{-1}), there was a reduction in CMC of 28.9% (2.884 kg) compared to those irrigated with 0.6 dS m^{-1} water (Figure 7B). Under these conditions, the absorption of nutrients by plants is affected because specific ions such as Na^+ can compete with other essential nutrients, causing disturbances in mineral nutrition, elongation, and cell division, consequently affecting the development of culms (Byrt et al., 2018; Hopmans et al., 2021).

In contrast to other crops, sugarcane productivity is directly related to vegetative growth because stalks are the main component of the yield of this crop. Gomathi and Thandapani (2014) evaluated the influence of salt stress on sugarcane growth and yield and found reductions in culm height (42.3%), culm diameter (38.8%), internode number (26.2%), internodal height (330.8%), cane mass (44.3%), and crop yield (38.5%). Lira et al. (2018), when evaluating the growth and productivity of sugarcane irrigated with brackish water and leaching fractions, they found that the salinity of the irrigation water up to 6.5 dS m^{-1} linearly reduced productivity and culm dry weight.

The industrial quality variables were not influenced by the electrical conductivity of the irrigation water (ECw). However, there were significant differences among the genotypes studied. The RB 92 579 cultivar had a higher percentage of apparent sugars (PAS), which was 7.80% higher than that of SP 81 3250 (Figure 8A). A similar trend was observed for soluble solids (SS), with an increase of 4.80% (Figure 8B), and for polarized sucrose (Pol), with an increase of 5.92% (Figure 8C) for the cultivar RB 92 579 in contrast to SP 81 3250.



Means followed by the same letters indicate no significant differences between them in the F-test ($p \leq 0.05$). ** - Significant at $p \leq 0.01$ by F test. Vertical bars indicate the standard error of the mean (n=4)

Figure 7. Culm mass per clump (CMC) as a function of cultivars (A), and as a function of electrical conductivity of irrigation water (ECw) (B)

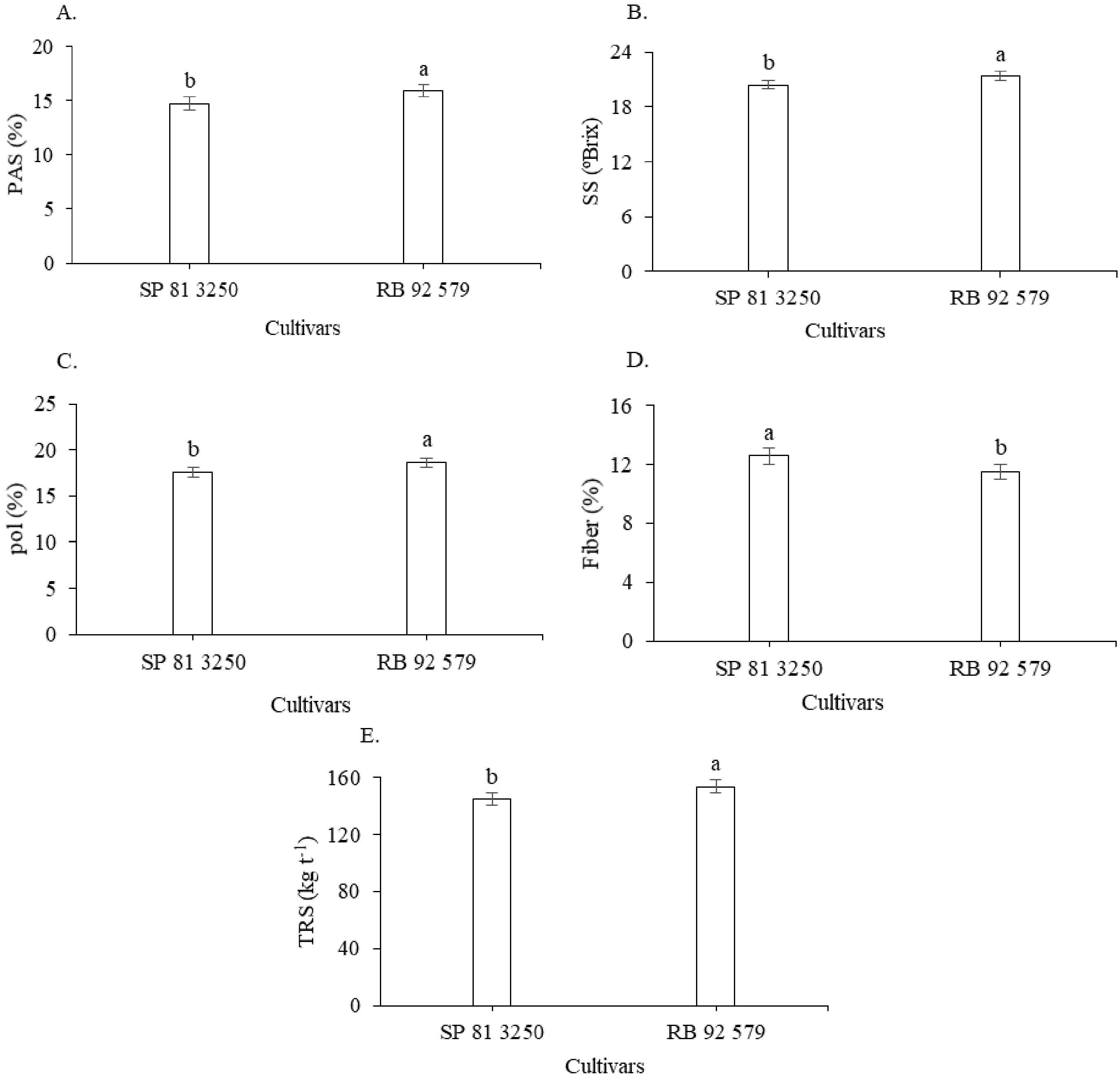
For the percentage of fiber (Figure 8D), cultivar SP 81 3250 obtained a higher percentage of water-insoluble matter contained in the cane (12.5%) than RB 92 579 (11.51%), corresponding to an increase of 9.12%. However, for total recoverable sugars (TRS) the cultivar RB 92579 had a higher percentage (6.14%) than the SP 81 3250 cultivar (Figure 8E).

Among all the technological variables studied, the cultivar RB 92 579 was superior to SP 81 3250, except for fiber. Therefore, from an industrial point of view, the fiber content is important for the energy balance of the industry because,

Table 3. Summary of analysis of variance for culm mass per clump (CMC) and industrial quality (percentage of apparent sugars - PAS, soluble solids - SS, polarized sucrose - Pol, percentage of water-insoluble matter contained in cane - fiber, juice purity - JP, and total recoverable sugars - TRS of sugarcane cultivars)

Sources of variation	DF	Mean squares						
		CMC	PAS	SS	Pol	Fiber	JP	TRS
Cultivars (C)	1	7.265*	13.328**	9.604*	10.836*	11.025*	8.082ns	791.299**
Salinity (ECw)	4	10.770**	1.267ns	0.775ns	1.698ns	0.195ns	7.661ns	40.419ns
Linear	1	42.559**	0.180ns	0.032ns	0.307ns	0.014ns	4.787ns	4.190ns
Quadratic	1	0.356ns	0.124ns	0.365ns	0.187ns	0.006ns	0.244ns	47.906ns
C × ECw	4	1.357ns	1.163ns	1.706ns	1.840ns	1.605ns	3.355ns	64.064ns
Block	3	5.111	3.348	4.575	4.272	3.006	1.427	219.002
Residue	27	1.050	1.563	1.989	2.058	1.518	4.509	98.599
C.V. (%)	-	11.86	8.17	6.75	7.93	10.23	2.46	6.65

GL, degrees of freedom; CV, coefficient of variation. ns - Not significant, * - Significant at 0.05, and ** - Significant at 0.01 probability by the F test



Means followed by the same letters indicate no significant differences between them in the F-test ($p \leq 0.05$). Vertical bars indicate the standard error of the mean (n=4)

Figure 8. Percentage of apparent sugars - PAS (A), soluble solids - SS (B), polarized sucrose - Pol (C), percentage of water-insoluble matter contained in the cane - fiber (D), and total recoverable sugars - TRS (E) as a function of cultivars

according to Rodolfo Junior et al. (2016), a fiber content higher than 10.5% is desirable for the industry, as less bagasse is burned to maintain the calorific value in the boilers. However, for ethanol and sugar production, the increase in fiber is undesirable because, besides hindering the juice extraction during processing, it has a negative relationship with the sugar content (Simões et al., 2021).

In this study, the divergence of fiber content between varieties may be related to the genetic characteristics of the materials and the cultivation environment. According to Simões et al. (2021), the percentage of fiber is a characteristic related to the genetic component, soil and climatic conditions, and crop management adopted. In this study, we found that the fiber content in cultivar SP 81 3250 was in agreement with the values reported in the literature (11-13 %).

In summary, all quality indices discussed in this study are used to calculate the amount of total recoverable sugars (TRS). It is the most important for both the industry and producers because it is through this index that industrial units determine the price paid to producers (Oliveira et al., 2012).

Conclusions

1. The sugarcane cultivar SP 81 3250 under irrigation with saline water of 0.6, 1.6 and 2.6 dS m^{-1} promoted a greater number of leaves in relation to RB 92 579, 125 days after planting.

2. The salinity of the irrigation water varying from 0.6 to 4.6 dS m^{-1} reduces the culm height and culm mass per clump of the sugar cane, regardless of the cultivar.

3. The sugarcane cultivar RB 92 579 had the highest culm height, number of tillers, culm mass per clump, percentage of apparent sugars, soluble solids, polarized sucrose, and total recoverable sugars, whereas SP 81 3250 had the highest percentage of water-insoluble matter contained in the cane, regardless of water salinity.

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