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# Salt stress in okra cultivated under different planting systems and mulch

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## Abstract

Salt stress directly affects the cultivation of glycophyte plants by reducing water and nutrient uptake, which rapidly affects growth rate and assimilate accumulation. Therefore, a planting system involving transplantation or direct seeding in combination with a plant mulch on the soil can mitigate the detrimental effects of salt stress. In this context, the objective was to evaluate the growth and biomass accumulation of okra crop under salt stress in different planting systems, with and without plant mulch. The study was conducted in polyethylene pots, under full sunlight, in Redenção - CE. The treatments were arranged in a completely randomized design, in a 3×2×2 factorial scheme, representing three electrical conductivities of irrigation water (0.5, 1.5 and 2.5 dS $m^{-1}$), two planting systems (direct sowing and transplanting) and with and without plant mulch, with 6 replications. Leaf area, leaf number, root length, and dry weight of okra are negatively affected by salt stress (2.5 dS $m^{-1}$) even under soil protection and different cropping systems. Plant mulch reduced the effects of salts on all biomass variables in both cropping systems at an electrical conductivity of 1.5 dS $m^{-1}$.

**Keywords:** *Abelmoschus esculentus (L.)*, salinity, soil protection

## Introduction

Okra (Abelmoschus esculentus (L)) has an annual production and a long harvesting period, requiring minimal cultural practices. It is well adapted to tropical conditions and is the only crop of the Malvaceae family that is important in Brazilian horticulture (Filgueira, 2012). The vegetable is mainly used for human consumption and has recently gained interest from the industrial sector for fiber production, becoming a good income alternative for both small and large farmers (Sales et al., 2021).

Its planting is usually done by direct sowing, which is the most recommended method of propagation. However, transplanting of seedlings is emerging as an alternative to improve plant nutrition and phytosanitation, allowing the selection of more vigorous and homogeneous plants (Silva-Matos et al., 2012).

Due to its adaptation to high temperature environments, the northeastern region is characterized as suitable for the cultivation of this plant. However, the region is characterized by spatial and temporal variability of rainfall and high evapotranspiration rates, making irrigation a key factor for agricultural development (Sousa et al., 2022).

It is noteworthy that the water used for full irrigation in this region tends to have a high salt content (Sousa et al., 2022). Excess salts in plants can lead to reduced water and nutrient uptake due to a decrease in the osmotic potential of the soil solution, causing disruptions in physiological and biochemical functions (Lima et al., 2021; Taiz et al., 2021). Plant responses vary according to their tolerance level, with okra having a salinity tolerance level in the saturation extract of less than 1.3 dS $m^{-1}$, making it sensitive to salinity (Maas, 1984).

In the literature, there are methods to mitigate salt stress such as the use of mulch cover. This conservation practice has been effective in controlling excessive


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water loss, thus favoring soil moisture and temperature (Barbosa et al., 2021). Canjá et al. (2021) observed that mulch mitigated the effects of salts on production and increased water use efficiency in peanut crop by direct sowing with the AC 130 genotype.

In this context, the objective was to evaluate the growth and biomass accumulation of okra crop in different planting systems under salt stress, in the presence and absence of mulch cover.

**Material and Methods**

The study was conducted under field conditions from September to October 2021, in the experimental area of the Seedling Production Unit Auroras (UPMA), to the Universidade da Integração Internacional da Lusofonia Afro-Brasileira (UNILAB), Redenção, Ceará.

The climate of the region is classified as Aw, characterized as rainy tropical, very hot, with rainfall distributed from summer to autumn. The climatic data for the experimental period are presented in **Figure 1**.

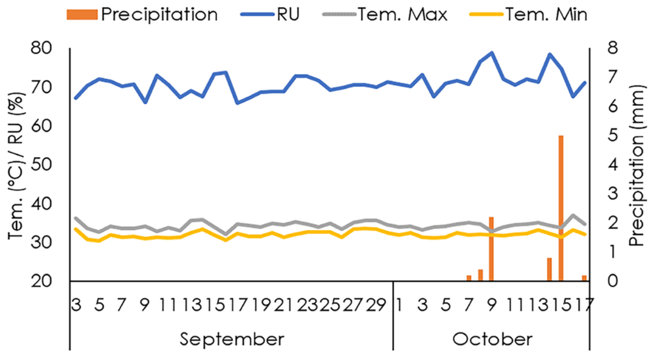


**Figure 1.** Maximum temperature (Max Temp) and minimum temperature (Min Temp), relative humidity (RH), and precipitation during the experiment.

The treatments were distributed in a completely randomized design, in a factorial scheme of 3×2×2, referring to three electrical conductivities of irrigation water - ECw (0.5, 1.5 and 2.5 dS m$^{-1}$), two planting systems (direct sowing and transplanting), with and without the addition of plant mulch, with 6 replications. The seedlings were produced in a protected environment, in polystyrene trays of 200 cells, each cell receiving one seed. At 12 days after sowing (DAS), after the emergence of the fourth true leaf, transplantation was carried out in polyethylene pots of 25 L capacity.

Direct sowing was done simultaneously with seedling production, so the plants are of the same age. Five seeds were planted per pot at a depth of two centimeters. The seeds used were of the Santa Cruz 47 variety. Thinning was carried out at 12 DAS, leaving the plant with the best vigor.

The pots and seedling trays were filled with substrate in a ratio of 5:2:1 (sandy soil, sand and cattle manure, respectively), whose chemical analysis is presented in **Table 1**".

**Table 1.** Chemical characteristics of the substrate used

| O.M | N | P | Mg | K | Ca | Na | pH | ESP | ECse |
|---|---|---|---|---|---|---|---|---|---|
| ----g kg$^{-1}$----- | | mg kg$^{-1}$ | --------cmol$_c$ dm$^{-3}$------ | | | | $H_2O$ | (%) | dS m$^{-1}$ |
| 15.35 | 0.93 | 6.7 | 1.5 | 0.35 | 4.5 | 0.07 | 7.0 | 1.03 | 0.9 |

O.M - Organic matter; ESP - Percentage of exchangeable sodium; ECse - electrical conductivity of the soil saturation extract.

The mulch used consisted of dried spontaneous-crop, in a layer of 10 cm. The treatments with different electrical conductivities of water and mulch started 10 days after transplanting (DAT).

The 0.5 dS m$^{-1}$ water came from the local supply. The saline solutions (1.5 and 2.5 dS m$^{-1}$) were prepared by adding sodium chloride (NaCl), calcium chloride ($CaCl_2.2H_2O$) and magnesium chloride ($MgCl_2.6H_2O$) to the supply water in a 7:2:1 ratio, according to the methodology proposed by Rhoades et al. (2000). The proportion of salts used is a representative approximation of most groundwater sources in the Brazilian semi-arid region.

Irrigation was performed manually, with a daily irrigation schedule, according to the principle of drainage lysimeters (Bernardo et al., 2019). A leaching fraction of 15% was used to avoid salt accumulation near the root system (AYERS & WESTCOT, 1999). The amount of water applied was determined by the following equation:

$$VI = \frac{(Vp - Vd)}{(1 - LF)}$$

where:

VL: volume of water to be applied in the irrigation event (mL);

Vp: volume of water applied in the previous irrigation event (mL);

Vd: volume of water drained (mL);

LF: leaching fraction of 0.15.

Fertilization was carried out according to the recommendation of Trani (2008), corresponding to 80 kg ha$^{-1}$ of N, 100 kg ha$^{-1}$ of P and 60 kg ha$^{-1}$ of K, with 8.8 g of urea (45% N), 27.8 g of single superphosphate (18% P) and 5.1 g of potassium chloride (60% K), respectively, according to the growth phase.

At 44 DAS, growth variables were analyzed in terms of plant height (PH, cm), measured from the base of the stem to the apex of the plant; root length (RL, cm), measured from the base of the stem to the point of greatest root concentration, both variables estimated using a ruler (cm); stem diameter (SD, mm), measured with a digital caliper 2 cm above the stem base, with results expressed in millimeters; Number of leaves (NL), obtained by direct counting; Leaf area (LA, cm²), estimated according to equation (02), using a correction factor of 0.63 (Oliveira et al., 2014).

LA = L x W x CF

where:

LA: leaf area (cm²); L: length (cm); W: width (cm); CF: correction factor (0.63).

During the same period (44 DAS), leaves, stems and roots were collected, identified, and placed in a forced-air oven at 65°C until a constant mass was obtained. Using an analytical balance expressed in grams (g), the following variables were evaluated: leaf dry mass (LDM), stem dry mass (SDM), and root dry mass (RDM). Total dry mass (TDM) was obtained by summing LDM + SDM + RDM.

The data were subjected to analysis of variance, and when significant by F-test, the means were compared by Tukey test ($p < 0.05$), using the ASSISTAT 7.7 Beta software.

## Results And Discussion

According to the summary of the analysis of variance (**Table 3**), a three-way interaction between the studied factors (electrical conductivity of irrigation water, planting systems and mulch) was observed for the variables plant height, leaf area, leaf dry mass, stem dry mass, root dry mass and total dry mass ($p>0.05$). However, leaf number showed a significant isolated effect for ECw.

The electrical conductivity of the irrigation water in combination with the planting system factor influenced stem diameter. A further interaction of planting system with mulch also influenced this variable ($p>0.05$). In contrast, root length was only influenced by ECw and planting system individually ($p>0.01$).

Presented to the **Figure 2** that under direct sowing system, without the addition of mulch, at the highest level of ECw (2.5 dS $m^{-1}$), the height was negatively affected, presenting a lower mean value (11.83 cm) compared to the treatment with mulch, which provided an increase of 31.86% in height. The effect of salt stress may be related to the excess of soluble salts present in the irrigation water, causing osmotic stress (Taiz et al., 2021), a fact that salt-sensitive plants tend to reduce the water absorption capacity, which is quickly reflected in the growth rate (Silva et al., 2022).

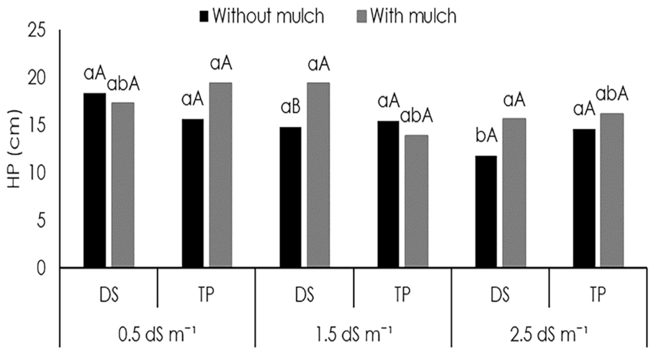


**Figure 2.** Plant height of okra, cultivated under different levels of electrical conductivity of irrigation water, planting systems (DS = direct sowing and TP = transplanting) with and without mulch. Columns with the same lowercase letters under the same mulch between different ECw and planting systems and columns with the same uppercase letters under the same ECw and planting system and different mulch do not differ from each other by Tukey test ($p \leq 0.05$)

However, the use of mulch reduces soil water loss due to evaporation and reduces salt accumulation in the surface layers of the soil at intermediate ECw (Pereira et al., 2015). Direct sowing is favored by moisture and reduced salt content near the absorption zone, facilitating water and nutrient uptake essential for carbon fixation and, consequently, plant physiological processes such as meristematic activity and cell elongation, which are critical for plant height (Taiz et al., 2021).

**Table 3.** Summary of the analysis of variance for plant height (PH), leaf area (LA), number of leaves (NL), stem diameter (SD), root length (RL), leaf dry mass (LDM), stem dry mass (SDM), root dry mass (RDM), and total dry mass (TDM) of okra, under different electrical conductivity levels of irrigation water, planting systems, with and without mulch.

| SV | DF | Mean squares | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | PH | LA | NL | SD | RL | LDM | SDM | RDM | TDM |
| ECw | 2 | 59.41* | 9185.29** | 58.23** | 12.41* | 156.58** | 90.77** | 7.73** | 5.68** | 213.10** |
| Planting systems (PS) | 1 | 2.19ns | 15343.47** | 0.58ns | 115.52** | 63.60** | 160.23** | 25.13** | 13.33** | 454.71** |
| Mulch (M) | 1 | 5.59ns | 2992.40ns | 3.33ns | 0.18ns | 3.93ns | 82.45** | 1.00ns | 1.02* | 123.03** |
| ECw × OS | 2 | 24.86ns | 3892.02* | 19.52ns | 15.08* | 31.50** | 11.46* | 1.93** | 1.45** | 35.66** |
| ECw × M | 2 | 12.84ns | 150.55ns | 3.50ns | 1.01ns | 0.58ns | 59.29** | 1.40** | 0.59ns | 77.74** |
| PS × M | 1 | 8.49ns | 5038.48* | 15.58ns | 17.42* | 7.20ns | 10.45ns | 1.63* | 2.81** | 38.31** |
| ECw × PS x M | 2 | 62.05* | 8192.93** | 16.17ns | 10.98ns | 2.06ns | 14.09** | 7.54** | 2.20** | 57.54** |
| Residual | 60 | 13.51 | 937.28 | 6.79 | 3.49 | 4.85 | 2.61 | 0.25 | 0.19 | 4.93 |
| CV% | | 22.92 | 33.28 | 26.88 | 24.33 | 18.61 | 26.38 | 30.21 | 34.45 | 24.43 |

SV: Source of variation DF: Degrees of freedom; (*) Significant by F test at 5%; (**) Significant by F test at 1%; ns: not significant; CV: Coefficient of variation; OA: overall average.

Sousa et al. (2020), studying the vegetative development of okra crop, found that water with an ECw of 2.0 dS m$^{-1}$ did not inhibit the variable; however, water with an ECw above this value resulted in growth inhibition, with a 17.37% reduction in plant height. Barbosa et al. (2021), who analyzed salt stress in cowpea crop, also found that mulch resulted in greater plant height compared to the treatment without mulch.

When evaluating leaf area (**Figure 3**), it was found that the 1.5 dS m$^{-1}$ treatment under direct sowing without the addition of mulch showed no statistical differences compared to 0.5 dS m$^{-1}$ under direct sowing with mulch. However, at 1.5 dS m$^{-1}$ ECw, direct sowing with mulch presented a positive difference of 46.7% and 53.6% compared to transplanting without and with mulch, respectively. Leaf expansion rate is rapidly affected by increasing salinity, as large leaf areas result in greater water evaporation, which can be detrimental to plant survival. As a result, plants develop morphological changes to abiotic stress by reducing leaf cell division

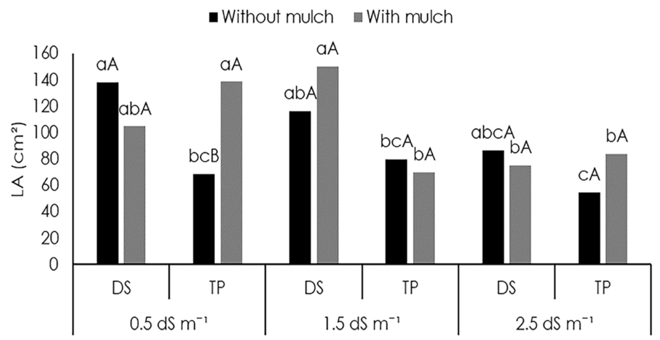


**Figure 3.** Leaf area of okra, cultivated under different levels of electrical conductivity of irrigation water, planting systems (DS = direct sowing and TP = transplanting) with and without mulch. Columns with the same lowercase letters under the same mulch between different ECw and planting systems and columns with the same uppercase letters under the same ECw and planting system and different mulch do not differ from each other by Tukey test ($p \leq 0.05$)

and expansion, resulting in reduced leaf area (Sousa et al., 2020; Taiz et al., 2021).

Plants grown by transplanting under irrigation with an ECw of 2.5 dS m$^{-1}$ differed from the other treatments, negatively affecting the leaf area of okra crop, resulting in the lowest mean for the variable (54.77 cm²). Transplanted plants have to adapt to the new environment by expending energy and redistributing photoassimilates. In this sense, mulching may have contributed to the adaptation to salinity and improved aboveground development by providing better soil protection and reducing evaporation losses (Pereira et al., 2015).

Similarly, Sousa et al. (2020), who studied the influence of irrigation water salinity on okra crop, concluded that salt stress negatively affected the leaf area of okra crops grown by direct sowing. Lima et al. (2020), who evaluated salt stress and different types of mulches in millet crop, also presented a decrease in this variable.

Increasing the electrical conductivity of the irrigation water significantly reduced the number of leaves, with similar reductions from the control treatment (0.5 dS m$^{-1}$) of 23.3% and 23.5% for ECw of 1.5 and 2.5 dS m$^{-1}$, respectively (**Figure 4**). Under salt stress conditions, inhibition of leaf emission is a response to avoid excessive

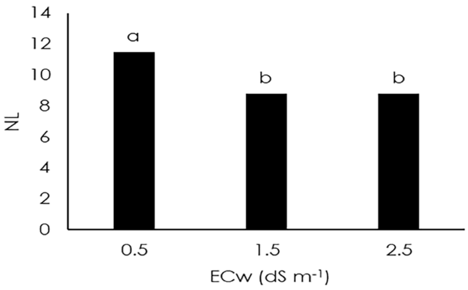


**Figure 4.** Number of leaves of okra, cultivated under different levels of electrical conductivity of irrigation water. Columns with the same letters do not differ from each other by Tukey test ($p \leq 0.05$)

transpiration and thereby maintain water uptake due to low soil water availability (Sales et al., 2021).

Magalhães et al. (2021), working with electrical conductivity in cowpea crop, observed a reduction in the number of leaves with an increase in salt concentration in irrigation water. Santos et al. (2020), studying arugula crop cultivated through transplanting, found that increasing electrical conductivity led to a reduction in the number of leaves.

Regarding the stem diameter variable, it is observed that direct sowing was statistically superior to transplanting at 0.5 and 1.5 dS m$^{-1}$, but there was

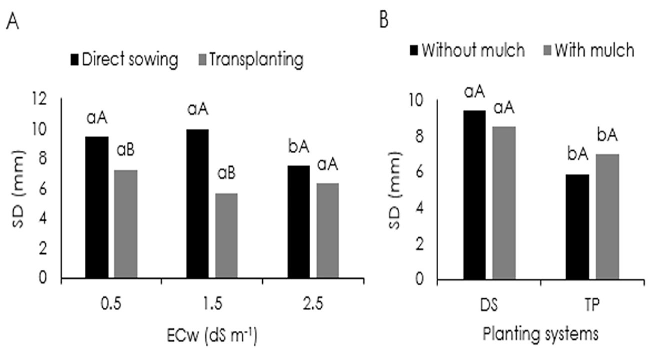


**Figure 5.** Stem diameter of okra, cultivated under different levels of electrical conductivity of irrigation water and planting systems (A); and under planting systems, with the presence and absence of mulch (B). Columns with the same lowercase letters under different ECw levels and the same planting system, and columns with the same uppercase letters under the same ECw level and different planting system, do not differ significantly according to the Tukey test ($p \leq 0.05$)

no statistical difference at 2.5 dS m$^{-1}$. The values were reduced by 20.5% and 24.5% at 0.5 and 1.5 dS m$^{-1}$, respectively, compared to 2.5 dS m$^{-1}$ (**Figure 5**A).

For stem diameter under salt stress and planting systems, it is revealed that plants with larger stem diameter tend to require more water, as well as respond to high salt content in irrigation water, morphological changes such as its decrease occur to maintain water transport and reduce salt entry, since their progressive absorption of these salts can be deposited linearly. Taiz et al. (2021) describe that the accumulation of ions ($Na^+$ and $Cl^-$) in plant tissues initially causes osmotic imbalance, and gradual absorption causes toxicity.

Direct sowing presented advantages under moderate salinity conditions, possibly because the plant is already established in the environment, unlike transplanting, which not only needs to acclimate to the new location, but also faces a limiting factor, which is salt stress. In this sense, the plant needs to redistribute photoassimilates that would be used in the stem to the roots to support the uptake of resources for its development (Taiz et al., 2021).

In evaluating the effect of salinity on okra stem diameter under direct sowing, Sousa et al. (2020) found that increasing EC from 1.0 to 5.0 dS m$^{-1}$ significantly affected this variable, with a reduction of 16.7%. Oliveira et al. (2022), who studied the stem diameter of five species under direct sowing and seedling planting, found that two of them showed no differences, while the others obtained the best averages under transplanting, a result partially contrary to the present study.

In Figure 5B, direct sowing provided the best averages for stem diameter regardless of the presence or absence of mulch cover, with higher averages of 37% without mulch and 18% with mulch compared to direct transplanting. The process of photoassimilate translocation may have been significantly reduced in stem diameter under transplanting, meaning the plant likely prioritized the roots to meet the needs of acquiring essential nutrients for plant acclimation (Taiz et al., 2021).

For root length, direct sowing showed a decrease with increasing salinity, with reductions of 23.6% and 42.7% compared to the control treatment. In the two highest salinity levels, there was no statistical difference between direct sowing and transplanting with increasing salinity, but when using lower salinity water, direct sowing was statistically superior to transplanting, showing an increase of 27.62% (**Figure 6**).

In part, salinity affects root development because they are in direct contact with salts (Guimarães et al.,

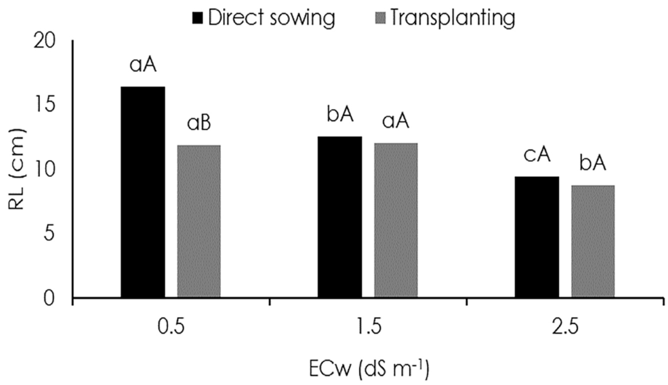


**Figure 6.** Root length of okra, cultivated under different levels of electrical conductivity of irrigation water and planting systems. Columns with lowercase letters are equal under different ECw and the same planting system, and columns with uppercase letters are equal under the same ECw and different planting systems, as determined by Tukey test (p ≤ 0.05)

2013), in addition to the osmotic potential that hinders water absorption. Direct sowing has the advantage that natural root growth has a greater depth without limitations on development, making it more resistant to adverse effects, while transplanted plant roots require time to re-establish in the field (Gribogi & Salles, 2007). However, both may appear similar after a period of time.

These results are similar to those found by Sousa et al. (2020) when studying okra crop under direct sowing, which was linearly inhibited, showing a reduction of 5.9 cm (25.76%) between the lowest and highest ECw. And by Sousa et al. (2019) with transplanted strawberry plants, they observed inhibition of root length with increasing salinity from 0.5 dS m$^{-1}$ to 2.5 dS m$^{-1}$, resulting in a maximum reduction of 30%.

For okra leaf dry mass (**Figure 7**), at intermediate ECw, direct sowing was superior to transplanting with or without the addition of mulch, with a positive difference for direct sowing of 58.73% and 52.46% without and with cover, respectively.

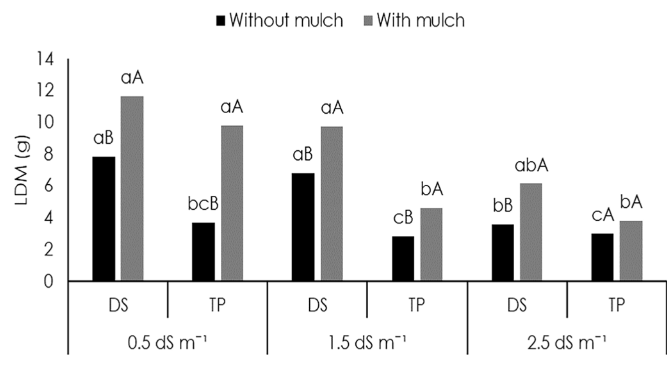


**Figure 7.** Leaf dry mass of okra, cultivated under different levels of electrical conductivity of irrigation water, planting systems (DS = direct sowing and TP = transplanting) with and without mulch. Columns with the same lowercase letters under the same mulch between different ECw and planting systems and columns with the same uppercase letters under the same ECw and planting system and different mulch do not differ from each other by Tukey test (p ≤ 0.05)

The decrease in leaf dry mass during transplanting, especially in saline waters, may be due to the deficit in water and nutrient absorption caused by transplanting, possible root hair breakage during seedling removal from trays, and the osmotic effect caused by increased ECw, aggravated by the lack of mulch, leading to insufficient water availability, thereby affecting physiological activities and interfering with biomass production (Freitas et al., 2014). Similar to this finding, Nascimento et al. (2017) reported a negative relationship between increased salinity of irrigation water and reduced leaf dry mass production. Silva Junior et al. (2023) found similar results to this study, where leaf dry mass of watermelon crop decreased with increasing ECw.

In both planting systems, the highest ECw (2.5 dS $m^{-1}$) resulted in the lowest SDM accumulation, but with superiority when mulch was used in direct sowing. In the 1.5 dS $m^{-1}$, direct sowing with mulch showed the highest mean for this variable, with 3.48 g. At the same ECw, the absence of mulch, both in direct sowing and in transplanting, presented inferior means compared to the treatment (**Figure 8**).

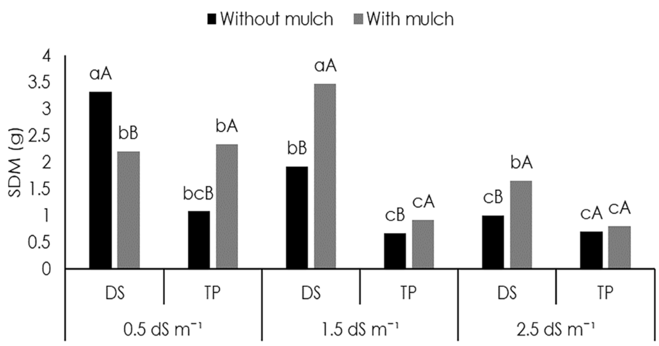


**Figure 8.** Stem dry mass of okra, cultivated under different levels of electrical conductivity of irrigation water, planting systems (DS = direct sowing and TP = transplanting) with and without mulch. Columns with the same lowercase letters under the same mulch between different ECw and planting systems and columns with the same uppercase letters under the same ECw and planting system and different mulch do not differ from each other by Tukey test ($p \leq 0.05$)

Transplanting was inferior to direct sowing, whether under salt stress conditions or not, due to the need to adapt to the environment, aggravated by the effects of ECw and even more by high temperatures and low soil humidity due to the absence of mulch. This affects the partitioning of assimilates, whose production under salt stress conditions is affected by stomatal closure to reduce water loss, thus reducing the rate of photosynthesis and consequently dry mass accumulation (Lacerda et al., 2020). Such behavior was observed by Nascimento et al. (2017) in okra crop, where increasing salinity led to a linear decrease in stem dry mass. A similar result was observed by Silva Junior et al. (2023), where increasing ECw resulted in a decrease in stem dry mass in watermelon plants, although with less intensity in direct sowing.

The lowest values for RDM, despite the variation in ECw, were obtained in transplanting without mulch, with a percentage difference of 67.22%, 53.33%, and 21.53% at sequential ECw levels (**Figure 9**).

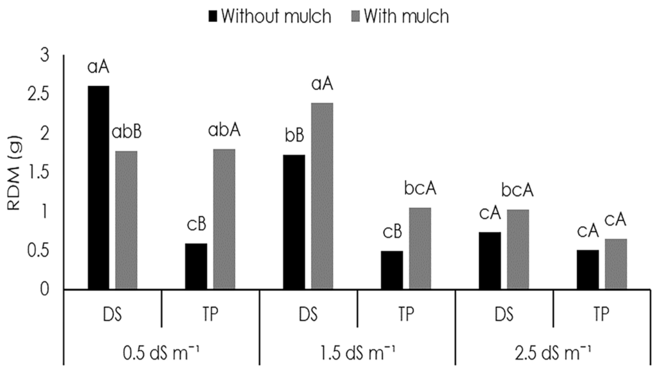


**Figure 9.** Root dry mass of okra, cultivated under different levels of electrical conductivity of irrigation water, planting systems (DS = direct sowing and TP = transplanting) with and without mulch. Columns with the same lowercase letters under the same mulch between different ECw and planting systems and columns with the same uppercase letters under the same ECw and planting system and different mulch do not differ from each other by Tukey test ($p \leq 0.05$)

This effect may be related to the reduction in water uptake caused by transplanting. During this process, soil disturbance leads to displacement of soil aggregates and even breakage of root hairs, which are responsible for increased uptake of water and ions from the soil. Therefore, newly transplanted seedlings need protection from water loss during the first days after transplanting in order to develop and re-establish contact with the soil, thereby increasing resistance to water stress due to high evapotranspiration and ECw, which exacerbates the deficit (Taiz et al., 2021; Silva Junior et al., 2023).

This limitation imposed by ECw on roots can be mitigated by the soil protective layer provided by mulching, which reduces water evaporation, prevents salt precipitation in the root zone, facilitates the uptake of essential resources, and consequently benefits root dry mass accumulation. Gouveitcha et al. (2021) observed a decrease in root dry mass in okra cultivars under salt stress, with reductions of 35.55% and 43.32% for 'Keleya' and 'Yodana' cultivars, respectively. Sousa et al. (2018), working with different ECw levels in maize crop, also found that root dry mass decreased at higher salinity levels; however, the presence of mulch mitigated the stress.

Total dry mass (**Figure 10**) was reduced by the transplanting technique, especially in treatments without

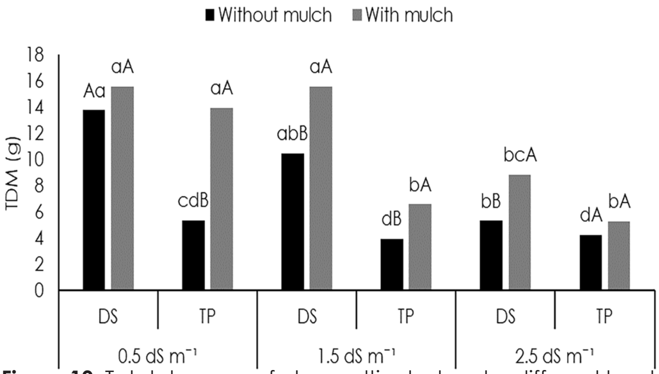


**Figure 10.** Total dry mass of okra, cultivated under different levels of electrical conductivity of irrigation water, planting systems (DS = direct sowing and TP = transplanting) with and without mulch. Columns with the same lowercase letters under the same mulch between different ECw and planting systems and columns with the same uppercase letters under the same ECw and planting system and different mulch do not differ from each other by Tukey test ($p \leq 0.05$)

mulch. The lowest values were obtained at ECw of 2.5 dS $m^{-1}$ (5.33 g and 8.83 g for direct sowing with and without mulch, respectively; similarly, for transplanting, 4.24 g and 5.52 g).

The presence of salts and/or water deficit reduces turgor pressure, causing stomatal closure, which affects $CO_2$ uptake and therefore assimilation (Taiz et al., 2021). This storage limitation may also be related to the presence of ions in the irrigation water, which can lead to plant toxicity and nutrient imbalance, a condition that can be mitigated by the use of mulch (Lima et al., 2020).

These findings are consistent with the work of Sousa et al. (2018), who evaluated the total dry mass variable in maize crop under mulch and salinity in irrigation water alone. They observed a 38.69% reduction in the range of 1 to 5 dS $m^{-1}$, and the use of mulch cover had a positive influence, with values of 58.74 g and 49.51 g for treatments with and without mulch, respectively. These results suggest that direct sowing (DS) favors crop establishment in the field; however, it has a strong effect under moderate salinity levels, as reported by Silva Junior et al. (2023) in watermelon crop.

**Conclusions**

Salt stress affects the leaf area of okra; however, up to moderate levels (1.5 dS $m^{-1}$), direct sowing and mulch mitigated such effects.

Leaf area, leaf number, root length, and the dry mass of leaf, stem, root, and total okra crop are negatively affected by salt stress (2.5 dS $m^{-1}$) even under soil protection and different planting systems.

Mulch cover reduced the salt effects on all biomass variables under both planting systems at the 1.5 dS $m^{-1}$ ECw level.

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