

## Growth and production of colored fiber cotton (*Gossypium hirsutum* L.) subjected to salt stress and potassium fertilization

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### Abstract

Temporal and spatial variation of rainfall in semiarid regions may lead to an increase in the concentrations of salts present in irrigation water, and it is necessary to adopt techniques to reduce the negative effects of salts on plants. Thus, the present study aimed to evaluate the growth and production of colored cotton cv. BRS Topázio as a function of irrigation using water with different levels of salinity and potassium doses. The experiment was carried out in pots adapted as lysimeters under greenhouse conditions, using a non-saline *Neossolo Regolítico* (Entisol) of sandy texture. The experimental design was randomized blocks, with 4 replicates, with treatments distributed in a 4 x 4 factorial scheme, corresponding to four levels of saline irrigation water electrical conductivity (1.5; 3.0; 4.5 and 6.0 dS m<sup>-1</sup>) and four potassium doses (50; 75; 100 and 125% of the recommendation), with a dose of 100% corresponding to 150 mg K<sub>2</sub>O per kg<sup>-1</sup> of soil. Irrigation using water of electrical conductivity (saline) above 1.5 dS m<sup>-1</sup> negatively affected the growth and production of cotton cv. BRS Topázio, and cotton seed weight was the most sensitive variable. Potassium doses above 50% of the recommendation in interaction with salinity reduced the height and leaf area of cotton cv. BRS Topázio.

**Keywords:** *Gossypium hirsutum* L., BRS Topázio., salinity.

**Abbreviations:** DAS\_days after sowing; ECw\_ irrigation water electrical conductivity; SL\_saline levels; SD\_Stem diameter; NL\_Number of leaves; LA\_Leaf area; PH\_Plant height; SCW\_Seed cotton weight; NB\_seed cotton weight; ABW\_Average boll weight; .

### Introduction

Cotton (*Gossypium hirsutum* L.) is cultivated in more than 60 countries, among which India, China, United States, Pakistan and Brazil stand out as the world's largest producers. The world production, for the 2018/2019 season, was around 26.3 million tons of seed cotton. In Brazil, according to a survey of the National Supply Company (CONAB, 2018), the states of Mato Grosso and Bahia account for more than 85% of the planted area in the country, with areas of 956.0 and 310.1 thousand hectares, respectively, followed by Goiás (39.7 thousand ha), Minas Gerais (39.3 thousand ha), Mato Grosso do Sul (31.0 thousand ha) and Maranhão (27.6 thousand ha) (ABRAPA 2017; 2018).

Colored-fiber cotton is a good alternative crop to be exploited, because it has higher added value compared to white-fiber cotton and provides family farmers with a source of income due to the plurality of products originating from it. It is one of the most used natural materials in the textile industry, in the form of either compact yarn or fabrics, also

acting as a complementary source in feed for ruminants, because the cottonseed has high nutritional value and is rich in lipids and proteins (Costa et al., 2017, Lima et al., 2019). Although cotton is a salt-tolerant crop, expressing a potential production (100%) at water electrical conductivity levels of up to 5.1 dS m<sup>-1</sup>, substantial reductions may occur in its growth and production in semiarid areas of Northeast Brazil, where water salinity levels can transform productive areas into areas with no agricultural use over time, because of the spatial and temporal variation of rainfall, which leads to water deficit and increased concentration of salts, especially Na<sup>+</sup> and Cl<sup>-</sup>, compromising the sustainability of soils and productive capacity of plants (Oliveira et al., 2013; Santos et al., 2016).

In general, the presence of excess salts in plants can cause limitations in physiological processes, especially gas exchanges and chlorophyll *a* fluorescence due to stomatal closure, and reduction in carbon fixation, directly affecting

plant growth and production. In addition, salinity leads to nutritional imbalance, as excessive amounts of  $\text{Na}^+$  in the soil solution result in absorption disorders which affect other nutrients, particularly Ca, Mg and K (Soares et al., 2018).

A possible alternative to reduce the harmful effects caused by water and/or soil salinity on plants is the supply of potassium (K). This macronutrient is important for the physiology of cotton plants and essential for their growth, yield, quality and resistance to stress. K deficiency, often found in saline soils, results in low growth and yield of crops, which makes K fertilization essential to ensure a productive cultivation of cotton (Lima et al., 2018).

Moreover, one of the main consequences of high  $\text{Na}^+$  and  $\text{Cl}^-$  concentrations is the negative effect on the absorption and/or use of several essential nutrients, such as K, causing imbalance in the  $\text{K}^+/\text{Na}^+$  ratio, responsible for osmotic adjustment of plants. However, one of the main objectives of the studies relating salinity to plant nutrition is to evaluate whether the addition of certain nutrients to soil solution, especially  $\text{K}^+$  and  $\text{Ca}^{2+}$ , can increase the tolerance of cultivated plants to salinity, since the established ionic competition can reduce the absorption of  $\text{Na}^+$  (Cruz et al., 2018).

Considering the social and economic importance of colored cotton and the need for generating alternatives to reduce the harmful effects of salinity on plants, this study aimed to evaluate the growth and production of cotton cv. BRS Topázio irrigated with waters of different salinity levels and K doses.

## Results and discussion

### *Effect of irrigation with saline water on the growth of colored fiber cotton*

According to the summary of analysis of variance (Table 1), it can be observed that the levels of irrigation water salinity significantly influenced stem diameter (SD), number of leaves (NL), leaf area (LA) and plant height (PH) of the colored cotton cv. BRS Topázio. Potassium doses did not significantly influence any of the variables analyzed, but their interaction with salinity levels (KD x SL) caused significant difference in the leaf area and plant height of cotton cv. BRS Topázio.

Cotton stem diameter was negatively affected by the levels of irrigation water salinity and, according to the regression equation (Figure 1A), decreased linearly by about 4.30% (1.34 mm) per unit increase in ECw, i.e., plants irrigated with ECw of  $6.0 \text{ dS m}^{-1}$  had a reduction of 1.34 mm in SD compared to those subjected to the salinity level of  $1.5 \text{ dS m}^{-1}$ . The reduction of stem diameter observed in plants cultivated under high salinity may be related to the osmotic and specific effects of ions, which retard cell expansion and division. Additionally, the reduction of water potential caused by the increase in irrigation water salinity can cause problems in the physiological and biochemical processes of the plants, directly leading to inhibition of their growth and production (Bezerra, 2018). In agreement with these results, Souza et al. (2018) also observed reduction in stem diameter after submitting BRS Jady cotton to ECw of  $6.8 \text{ dS m}^{-1}$ .

The number of leaves decreased linearly as the levels of irrigation water salinity increased and, according to the

regression equation (Figure 1B), there was a reduction of 9.42 leaves (40.39%) in plants irrigated with  $6.0 \text{ dS m}^{-1}$  water compared to those irrigated with  $1.5 \text{ dS m}^{-1}$  water. According to Munns & Tester (2008), reduction in the number of leaves, due to the increment in water salinity levels, may be related to the decrease in the osmotic potential, which hampers water conduction toward plant cells. Silva et al. (2017) studied the effect of salinity on BRS Topázio cotton and also found reduction, equal to 8.68 leaves when plants were irrigated using  $6.0 \text{ dS m}^{-1}$  water. According to these authors, this phenomenon contributes to reducing the capacity of production of organic assimilates, which results in inhibition of cotton growth.

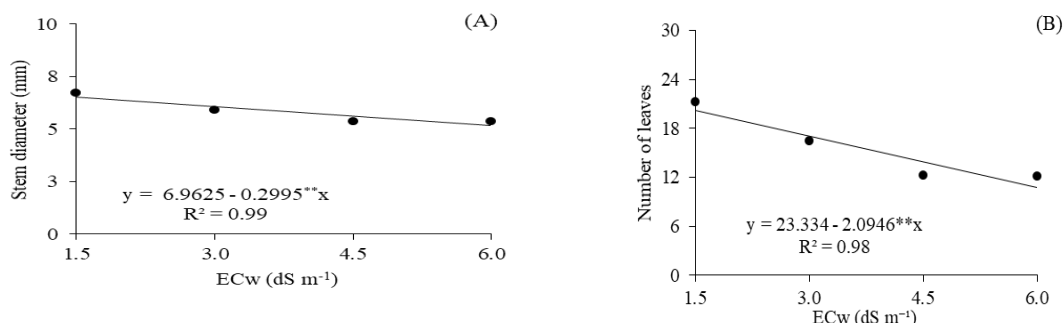
For the interaction between irrigation water salinity and K doses (Figure 2A), the regression equation indicated a reduction of 9.17% (4.22 cm) per unit increase in irrigation water electrical conductivity, regardless of the K doses of studied. In addition, the highest value of PH (51.81 cm) was observed in plants subjected to irrigation with  $1.5 \text{ dS m}^{-1}$  water and fertilized with  $\text{K}_2\text{O}$  dose of 50% (75 mg of  $\text{K}_2\text{O kg}^{-1}$  of soil) and the lowest value (27.06 cm) was obtained in plants irrigated with  $6.0 \text{ dS m}^{-1}$  water and fertilized with  $\text{K}_2\text{O}$  dose of 125% (187.5 mg of  $\text{K}_2\text{O kg}^{-1}$  of soil), corresponding to a reduction of 47.77% (24.75 cm) compared to plants with highest value of PH. The reduction of plant height due to increased salinity can be attributed to the increase in the osmotic pressure of the medium and diversion of energy to the accumulation of compatible solutes and to the consequent reduction in the osmotic potential of the soil solution, a situation that led to alteration in the absorption of water and nutrients, resulting in a reduction of crop growth (Graciano et al., 2011). Bonifácio et al. (2018), studying the effects of K fertilization and irrigation with saline waters on the growth of guava rootstock, observed a linear reduction in plant height as K doses increased. These authors stated that the increase in K dose does not always result in beneficial effects on plants and that the salinity from the fertilizer, caused by high concentrations of K applied, can even be more harmful than that caused by high concentrations of salts such as sodium and chloride.

The leaf area of cotton cv. BRS Topázio decreased linearly with the interaction between the factors (SL x KD) and, according to the regression equation (Figure 2B), there was a reduction of 13.17% per unit increase in irrigation water electrical conductivity, at any of the  $\text{K}_2\text{O}$  doses studied. Thus, the highest value ( $932.66 \text{ cm}^2$ ) of leaf area was obtained in plants irrigated with  $1.5 \text{ dS m}^{-1}$  water and fertilized with 50% of  $\text{K}_2\text{O}$  (75 mg of  $\text{K}_2\text{O kg}^{-1}$  of soil), while the lowest value ( $194.35 \text{ cm}^2$ ) was obtained in plants irrigated with the highest salinity level ( $6.0 \text{ dS m}^{-1}$ ) and fertilized with 125% (187.5 mg of  $\text{K}_2\text{O kg}^{-1}$  of soil), which led to a reduction of  $738.31 \text{ cm}^2$  between the highest and lowest values of leaf area. It can be noted that such reduction is largely due to the increasing levels of water salinity, but also due to the abscission of adult leaves. According to Oliveira (2010), anatomical and morphological alterations commonly occur in plants under salt stress conditions, which results in the reduction of transpiration, as an alternative to maintain the low absorption of saline water. Araújo et al. (2018), evaluating the effects of K fertilization on cashew rootstocks, also found a reduction in leaf area and stated that the nutritional requirements of the plants vary according to their development stage; hence,

**Table 1.** Summary of analysis of variance for stem diameter (SD), number of leaves (NL), Leaf area (LA) and plant height (PH) of the cotton cv. BRS Topázio irrigated with waters of different salt levels and potassium doses at 72 days after sowing.

| Source of variation         | GF | Mean squares       |                     |                         |                      |
|-----------------------------|----|--------------------|---------------------|-------------------------|----------------------|
|                             |    | SD                 | NL                  | LA                      | PH                   |
| Salinity Level (SL)         | 3  | 4.72**             | 220.74**            | 725869.54**             | 1041.05**            |
| Linear regression           | 1  | 12.11**            | 592.20**            | 1998619.55**            | 2980.03**            |
| Quadratic regression        | 1  | 2.00**             | 63.02**             | 176115.75**             | 127.07*              |
| Doses K <sub>2</sub> O (KD) | 3  | 0.32 <sup>ns</sup> | 1.29 <sup>ns</sup>  | 54866.81 <sup>ns</sup>  | 175.38 <sup>ns</sup> |
| Linear regression           | 1  | 0.73 <sup>ns</sup> | 2.20 <sup>ns</sup>  | 159466.83 <sup>ns</sup> | 423.20**             |
| Quadratic regression        | 1  | 0.09 <sup>ns</sup> | 1.68 <sup>ns</sup>  | 2327.98 <sup>ns</sup>   | 22.55 <sup>ns</sup>  |
| Interaction (SL x KD)       | 9  | 0.34 <sup>ns</sup> | 10.87 <sup>ns</sup> | 64777.63**              | 47.97**              |
| Blocks                      | 2  | 0.26 <sup>ns</sup> | 16.36 <sup>ns</sup> | 18959.28 <sup>ns</sup>  | 76.57 <sup>ns</sup>  |
| Residual                    | 30 | 0.20               | 7.97                | 11910.24                | 25.28                |
| CV (%)                      |    | 7.67               | 18.25               | 19.93                   | 12.20                |

<sup>ns</sup>, \*, \*\* not significant, significant at p < 0.01 and p < 0.05, respectively.

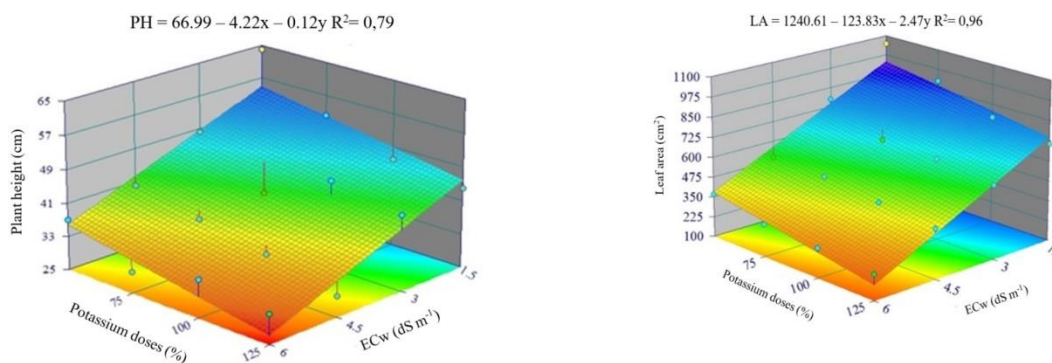


**Fig 1.** Stem diameter (SD), number of leaves (NL) the cotton cv.BRS Topázio irrigated with waters of different salt levels and potassium doses at 72 days after sowing.

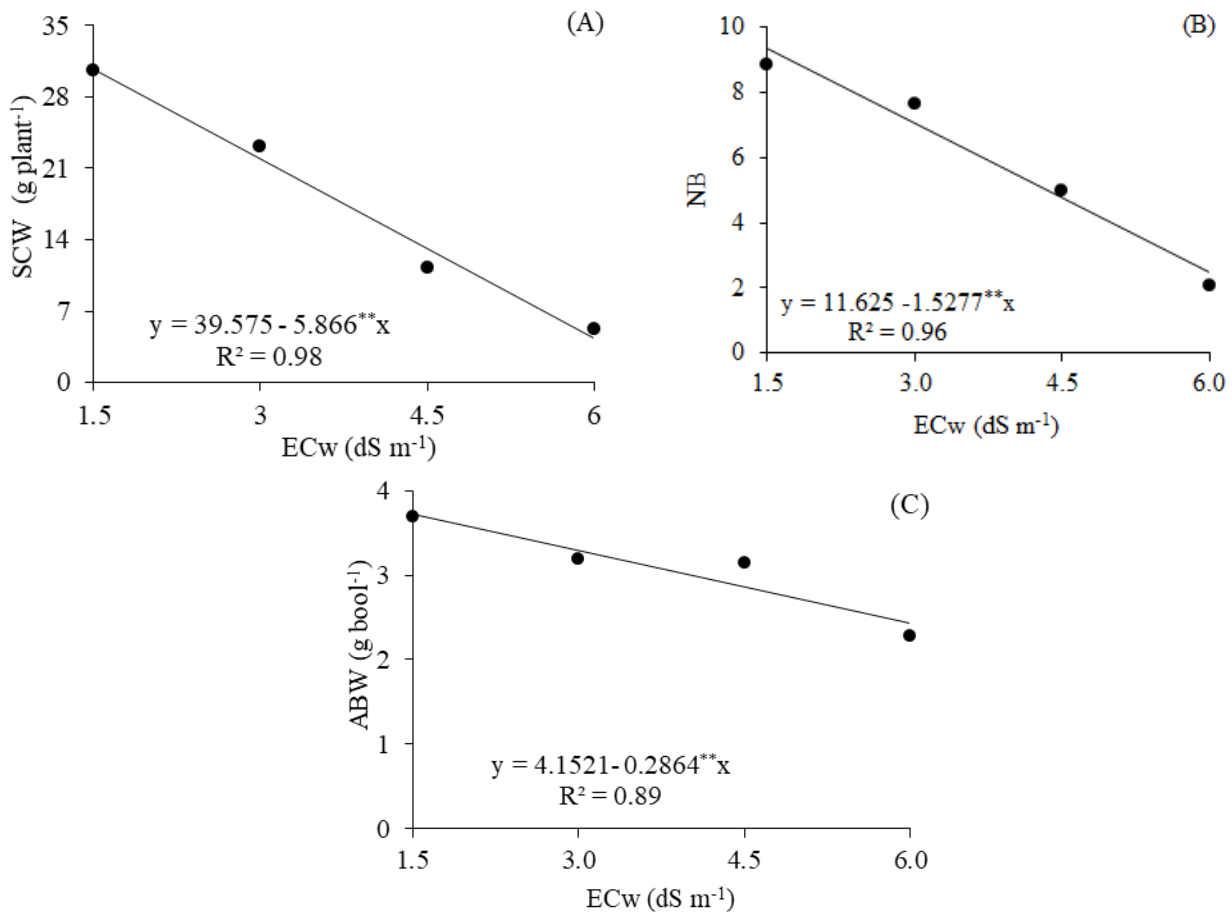
**Table 2.** Summary of analysis of variance for seed cotton weight (SCW), number of bolls (NB) and the average boll weight (ABW) of the cotton cv.BRS Topázio irrigated with waters of different salt levels and potassium doses at 136 days after sowing.

| Source of variation         | GF | Mesquares           |                    |                     |
|-----------------------------|----|---------------------|--------------------|---------------------|
|                             |    | SCW                 | NB                 | ABW                 |
| Salinity Level (SL)         | 3  | 1571.02**           | 108.40**           | 4.13**              |
| Linear regression           | 1  | 4644.64**           | 315.10**           | 3.97**              |
| Quadratic regression        | 1  | 5.40 <sup>ns</sup>  | 9.18 <sup>ns</sup> | 5.52*               |
| Doses K <sub>2</sub> O (KD) | 3  | 7.28 <sup>ns</sup>  | 2.52 <sup>ns</sup> | 3.02 <sup>ns</sup>  |
| Linear regression           | 1  | 16.52 <sup>ns</sup> | 0.20 <sup>ns</sup> | 3.19 <sup>ns</sup>  |
| Quadratic regression        | 1  | 3.85 <sup>ns</sup>  | 1.02 <sup>ns</sup> | 0.016 <sup>ns</sup> |
| Interaction (SL x KD)       | 9  | 9.82 <sup>ns</sup>  | 5.96 <sup>ns</sup> | 3.12 <sup>ns</sup>  |
| Blocks                      | 2  | 0.27 <sup>ns</sup>  | 2.14 <sup>ns</sup> | 0.35 <sup>ns</sup>  |
| Residual                    | 30 | 23.6                | 3.12               | 1.07                |
| CV (%)                      |    | 17.32               | 18.29              | 19.70               |

<sup>ns</sup>, \*, \*\* not significant, significant at p < 0.01 and p < 0.05, respectively.



**Fig 2.** Response surface graph for Leaf area (LA) and plant height (PH) of the cotton cv. BRS Topázio irrigated with waters of different salt levels and potassium doses at 72days after sowing.



**Fig 3.** Seed cotton weight (SCW), number of bolls (NB) and the average boll weight (ABW) of the cotton cv. BRS Topázio irrigated with waters of different salt levels and potassium doses at 136 days after sowing.

antagonistic effects may occur when a larger quantity than that required by the species is applied.

#### **Irrigation water salinity effect on the production of colored fiber cotton**

Based on the summary of the analysis of variance (Table 2), it can be verified that the levels of irrigation water salinity significantly influenced seed cotton weight (SCW), number of bolls (NB) and the average boll weight (ABW). K doses and its interaction with water salinity did not influence any of the studied variables ( $P > 0.05$ ).

Irrigation with saline water caused a linear reduction ( $P < 0.01$ ) in the seed cotton weight (SCW) of the cultivar BRS Topázio and, according to the regression equation (Figure 3A), this variable decreased by 14.82% per unit increase in ECw, i.e., plants irrigated with ECw of 6.0 dS m<sup>-1</sup> had a reduction of 66.70% (26.397 g plant<sup>-1</sup>) compared to those irrigated with ECw of 1.5 dS m<sup>-1</sup>. The decrease of production due to increments in ECw can be attributed to the lower water absorption by plants under salt stress, resulting from the lower water potential of the soil, as concluded by Soares et al. (2018). Results found by Santos et al. (2016) corroborate those of the present study, because these authors observed a reduction in the production of the cotton cultivar BRS Topázio, reinforcing its sensitivity to the increase in irrigation water salinity.

The regression analysis performed for the number of bolls (NB) indicated a linear reduction of 13.14% per unit increase in water salinity (Figure 3B), i.e., there was a loss of 6.88 bolls per plant (59.13%) in plants irrigated using water with ECw of 6.0 dS m<sup>-1</sup>, compared to those irrigated with 1.5 dS m<sup>-1</sup> water. Reduction in plant fecundity stands out among the deleterious effects of salinity, leading to higher rates of flower abortion, changes in metabolic reactions, followed by the fall in production, in order to attenuate the damage caused by salt stress (Torabi et al., 2013). Oliveira *et al.* (2012), working with the Delta Opal cotton cultivar, under irrigation water salinity, also found a reduction in the number of bolls per plant (6.46%) per unit increase in salinity.

The increasing levels of water salinity also linearly reduced ( $p < 0.01$ ) the average boll weight of BRS Topázio cotton plants (Figure 3C). The regression equation showed a decrease of 6.89% per unit increase in electrical conductivity, which corresponds to a reduction of 31.03% (1.28 g) in the average boll weight of plants irrigated with 6.0 dS m<sup>-1</sup> water compared to those irrigated with the lowest level of salinity (1.5 dS m<sup>-1</sup>). Decrease in the average boll weight, as a consequence of the increase in ECw, may result from the reduction of osmotic potential, which leads to metabolic disorders, mainly in relation to the absorption of water and nutrients by plants, resulting in a decrease in cotton production (Sobrinho et al., 2007). According to Souza et al. (2018), who found reduction in seed cotton

weight as the water electrical conductivity increased, such reduction may result from the accentuated decrease in the growth of cotton plants, evidenced by SD, PH and LA, caused by the reduction in the osmotic potential of the soil solution due to the high saline concentration. This situation imposes greater energy expenditure on plants for water absorption and maintenance of metabolic activity, besides the synthesis of organic solutes for osmoregulation and/or protection of macromolecules. As a consequence, plant growth is reduced, resulting in lower production.

## Materials and methods

### Location and treatments

The experiment was conducted in the period from September 2016 to February 2017 in pots adapted as drainage lysimeters in a greenhouse belonging to the Center for Technology and Natural Resources of the Federal University of Campina Grande (CTRN/UFCG), located in the municipality of Campina Grande, Paraíba, situated by local geographic coordinates 07° 15' 18" S, 35° 52' 28" W and average altitude of 550 m.

The experiment was set up in a randomized block design in a 4 x 4 factorial arrangement, with three replicates, and the treatments consisted of four levels of irrigation water electrical conductivity - ECw (1.5; 3.0; 4.5 and 6.0 dS m<sup>-1</sup>) and four K doses - KD (50, 75, 100 and 125% of the recommendation). The dose of 100% corresponded to 150 mg K<sub>2</sub>O kg<sup>-1</sup> of soil, as recommended by Novais et al. (1991) for pot experiments. The waters with different saline levels (SL) were prepared by dissolving sodium chloride (NaCl) in supply water available in the municipality of Campina Grande (ECw = 1.10 dS m<sup>-1</sup>), considering the relationship between ECw and the concentration of salts (10\*mmolc L<sup>-1</sup> = ECw dS m<sup>-1</sup>), according to Richards (1954).

### Plant material

The plant material used in the study was the colored-fiber cotton cv. BRS Topázio, as it has a high percentage of fiber (43.5%), uniformity (85.2%) and resistance (31.9 gf/tex), which confer excellent characteristics, comparable to those of white-fiber cultivars and superior to those of other cultivars of colored fibers. The average yield achieved by the cotton cultivar BRS Topázio under irrigation is 2.825 kg ha<sup>-1</sup> (EMBRAPA, 2011).

### Experimental setup and conduction

Drainage lysimeters with capacity for 20 L and a 4-mm-diameter drain on the base to allow the leachate to drain were used in the experiment. The tip of the drain inside the lysimeter was wrapped with a nonwoven geotextile (Bidim OP 30) to avoid clogging by soil material. A plastic bottle was placed below each drain in order to collect the drained water and estimate water consumption by plants. The lysimeters were filled with 0.5-kg layer of crushed stone and 22 kg of *Neossolo Regolítico* (Entisol) of sandy texture (0-0.20 m), from the municipality of Esperança-PB. Its physical-hydraulic characteristics were determined according to Teixeira et al. (2017): Ca<sup>2+</sup> = 3.49 cmol<sub>c</sub>kg<sup>-1</sup>; Mg<sup>2+</sup> = 2.99 cmol<sub>c</sub>kg<sup>-1</sup>; Na<sup>+</sup> = 0.17 cmol<sub>c</sub> kg<sup>-1</sup>; K<sup>+</sup> = 0.21 cmol<sub>c</sub> kg<sup>-1</sup>; H<sup>+</sup> = 5.81

cmol<sub>c</sub> kg<sup>-1</sup>; Al<sup>3+</sup> = 0 cmol<sub>c</sub> kg<sup>-1</sup>; CEC = 12.67 cmol<sub>c</sub> kg<sup>-1</sup>; organic matter = 18.30 dag kg<sup>-1</sup>; P = 18.2 mg kg<sup>-1</sup>; pH in water (1:2.5) = 5.63; Electrical conductivity of the saturation extract (dS m<sup>-1</sup>) = 0.61; SAR (mmol L<sup>-1</sup>)<sup>1/2</sup> = 1.46; sand, silt and clay = 572.3, 100.8 and 326.9 g kg<sup>-1</sup>; moisture contents at 33.42 and 1519.5 kPa = 12.68 and 4.98 dag kg<sup>-1</sup>.

Prior to sowing, the soil moisture content was raised to field capacity using the respective saline waters, according to the treatments. After sowing, irrigation was carried out every day using the waters from the treatments, applying in each lysimeter a water volume sufficient to maintain the soil moisture content close to field capacity. The applied volume was determined according to the requirement of the plants, estimated by water balance: water volume applied minus water volume drained in the previous irrigation.

In each lysimeter, seven seeds of BRS Topázio cotton were sown at 2 cm depth and equidistantly distributed. At 18 and 36 days after sowing (DAS), thinning was performed in order to leave only one plant per lysimeter. After thinning, the experimental unit was composed of one plant by lysimeter. Fertilization with phosphorus (P), nitrogen (N) and K was performed based on the recommendation of Novais et al. (1991), considering the levels shown in the soil analysis, applying 300 mg of P<sub>2</sub>O<sub>5</sub>, 150 mg of K<sub>2</sub>O and 100 mg of N kg<sup>-1</sup> of soil, using monoammonium phosphate, urea and potassium chloride as a sources of nutrients, respectively. P was entirely applied at planting, whereas K and N fertilizers were equally split: one third of the dose of each nutrient was applied at 15 DAS and the remainder was supplied in three equal applications by fertigation with saline waters at 15-day intervals.

The micronutrients were applied through the leaves at 15, 33, 51, 69, 87 DAS, using 1.5 L of a solution containing 3.0 g<sup>-1</sup> L of Ubyfol (N - 15%; P<sub>2</sub>O<sub>5</sub> -15%; K<sub>2</sub>O - 15%; Ca - 1%; Mg - 1.4%; S -2.7%; Zn - 0.5%; B - 0.05%; Fe - 0.5%; Mn - 0.05%; Cu - 0.5%; Mo - 0.02%). The phytosanitary control was carried out preventively, applying insecticides of the carbamate and neonicotinoid chemical groups, fungicide of the triazole chemical group, and acaricide of the abamectin chemical group.

### Variables analyzed

Treatment effects on BRS Topázio cotton were evaluated through growth variables: stem diameter (SD), number of leaves (NL) and plant height (PH) at 72 DAS, and production variables: seed cotton weight (SCW), number of bolls (NB) and average boll weight (ABW) at 136 DAS.

Plant height was measured taking as reference the distance from the collar to the attachment point of the apical meristem. Stem diameter was measured at 5 cm from plant collar. NL was quantified considering leaves with minimum length of 2 cm and at least 50% of photosynthetically active area. Leaf area was obtained by measuring the length of the midrib of all leaves, and leaf area per plant was determined by the sum of the leaf areas of all leaves, following the methodology described by Grimes & Carter (1969), according to Eq. 1:

$$y = \Sigma(0.4322 x^{2.3002}) \quad (1)$$

Where: y = total leaf area; x = midrib length of cotton leaf.

The number of bolls was determined by the number of bolls harvested per plant. Harvest was performed manually when 90% of the capsules were open, at 136 DAS. The bolls were

put in previously identified plastic bags and weighed on a scale with precision of 0.01 g, to obtain the seed cotton weight and the average boll weight.

### Statistical analysis

The collected data were subjected to analysis of variance by F test at 0.05 and 0.01 probability levels and, in the cases of significance, linear and quadratic polynomial regression analysis was performed using the program SISVAR-ESAL (Ferreira, 2014).

### Conclusions

Irrigation using water with electrical conductivity above 1.5 dS m<sup>-1</sup> negatively affects the growth and production of cotton cv. BRS Topázio, and seed cotton weight is the most sensitive variable; Potassium doses above 50% of the recommendation in interaction with salinity reduces the height and leaf area of cotton cv. BRS Topázio.

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