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RESEARCH ARTICLE

SALT STRESS, NITROGEN AND POTASSIUM FERTILIZATION ON GROWTH AND FIBER QUALITY OF COLORED COTTON

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ABSTRACT

This study aimed to evaluate growth, production and technological characteristics of the fiber of colored cotton, cv. 'BRS Topázio', under saline water irrigation, potassium (K) fertilization and different proportions of nitrate and ammonium. The study was conducted in drainage lysimeters under greenhouse conditions, in a eutrophic Grey Argisol with sandy clay loam texture, in the municipality of Campina Grande-PB, Brazil, from November 2014 to March 2015. The experiment was conducted in a randomized block design, testing five K doses (50; 75; 100; 125 and 150% of the recommendation for pot experiments) and five proportions of nitrate and ammonium (100/0; 75/25; 50/50; 25/75; 0/100 mg of N kg^{-1} of soil). The dose of 100% of K corresponded to 150 mg K_2O kg^{-1} of soil. There was significant effect of the interaction between K doses and proportions of nitrate/ammonium on plant growth and on the technological characteristics of the fibers of 'BRS Topázio' cotton cultivated under salt stress. Fertilization with 50/50 mg of nitrate/ammonium along with 50% of the K recommendation favored higher growth, production and fiber quality of colored cotton, cv. 'BRS Topázio'.

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INTRODUCTION

Herbaceous cotton (*Gossypium hirsutum* L.) is one of the main crops cultivated in the world for being considered as the most important among the commercialized textile fibers, taking into consideration the volume of the production and the monetary value of its production chain (Mao *et al*., 2015; Barcelos *et al*., 2016). In Brazil, the crop is widely distributed and is cultivated in more than fifteen states, part of them located in the Northeast region, one of the main cotton-producing regions of the country (Oliveira *et al*., 2012; CONAB, 2015). In this region, especially in the semi-arid area, problems of salinity and/or sodicity are common, due to high concentration of sodium salts in the water resources and accumulation in the soil, because of the high evaporation demand and low rainfall, which prevents the leaching of salts, promoting the accumulation in the soil, besides factors related to the it's, mineralogy of these soils, which contribute to the continuous release of salts containing sodium (Medeiros *et al*., 2003; Oliveira *et al*., 2012; Sá *et al*., 2015). The excess of salts and/or sodium promotes adverse effects on the plants, especially osmotic effect and ionic and nutritional disorders (Muns &Tester, 2008; Almeida *et al*., 2015;Sá *et al*., 2015).According to Epstian & Bloom (2006), the nutritional imbalance is more pronounced in relation to the other deleterious effects of the salt stress. These effects can be even more evident in crops conducted with less technology, where there is no adequate management of irrigation and fertilization, such as in the Brazilian semi-arid region, originating very intensive fertilization systems, with insufficient and/or imbalanced applications, and generating economic losses, which, associated with inadequate management of irrigation, can intensify environmental impacts like the salinization of the soils.Nitrogen (N) and potassium (K) are among the nutrients required in greatest amounts by cotton. The supply of N and K^+ in adequate amounts stimulates cotton growth, flowering and increase yield, through the increment in mean diameter of

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the bolls, boll weight and fiber quality, improving the micronaire index, besides reducing the percentage of short fibers and increasing fiber resistance, since these nutrients act structurally in the composition of important biomolecules and act in the metabolism as enzymatic activators (Freitas *et al*., 2007; Encher *et al*., 2009; Ferrari *et al*., 2012; Kaneko *et al*., 2014).Besides the amount of nutrient in the soil, the form in which it is present in the cultivation environment may limit crop performance (Guimarães *et al*., 2014). As observed for N, however, different ionic forms cause complex effects on plant growth and metabolism, leading to positive and negative physiological responses, because, when N is absorbed in the form of NO_3^-, its conversion to NH_4^+, for later incorporation in organic compounds, requires large consumption of reducing potential, thus a great expenditure of energy, which may be limiting under salt stress conditions (Masclaux-Daubresse *et al*., 2010; Guo*et al*., 2012; Bartelheimer & Poschlod, 2013).
Studies evaluating the interaction between N and K are still incipient for the cotton crop, especially when associated with N-fertilization with different proportions of nitrate and ammonium. In this context, this study aimed to evaluate growth and technological characteristics of the fiber of colored cotton, cv. 'BRS Topázio', under irrigation with saline water as a function of K fertilization and different proportions of nitrate and ammonium.

MATERIAL AND METHODS

The study was conducted from November 2014 to March 2015, using pots adapted as drainage lysimeters in a greenhouse at the Center of Technology and Natural Resources of the Federal University of Campina Grande (CTRN/UFCG), located in the municipality of Campina Grande-PB, Brazil, at the geographic coordinates of 7°15'18'' S, 35°52'28'' W and mean altitude of 550 m.The experimental design was completely randomized blocks, in a 5 x 5 factorial arrangement, with three replicates, and the treatments consisted of five proportions of nitrate/ammonium (NO_3^-/NH_4^+) (100/0; 75/25; 50/50; 25/75; 0/100 mg of N kg^{-1} of soil) and five doses of K-DK [50; 75; 100; 125 and 150% of the recommendation for pot experiments (Novais *et al*., 1991)]. The K dose referring to 100% corresponded to 150 mg K_2O kg^{-1} of soil.The irrigation water was prepared using the salts NaCl, $CaCl_2.2H_2O$ and $MgCl_2.6H_2O$ in a proportion equivalent to 7:2:1, by adjusting the concentration of salts in the public-supply water of the municipality of Campina Grande-PB, in order to obtain ECw of 6.0 dS m^{-1}, considering the relationship between ECw and the concentration of salts (10*$mmol_c$ L^{-1}=ECw dS m^{-1}), according to Richards (1954). After preparation and ECw calibration, using a portable conductivity meter, the saline water was stored in plastic containers with capacity for 200 L, which were later covered in order to avoid possible losses through evaporation.

Drainage lysimeters with capacity for 20 L were used for the cultivation of the plants. The bottom of each recipient was perforated to allow drainage and connected to a drain (4-mm diameter). The tip of the drain inside the lysimeter was involved in a nonwoven geotextile (Bidim OP 30) to avoid clogging by soil material. A plastic bottle was placed below each drain for the collection of the drained water and estimation of water consumption by the plant.For the cultivation, the soil material was prepared using a 0.5-kg layer of crushed stone, followed by 26 kg of a eutrophic Grey Argisol of sandy clay loam texture, from the district of São José da Mata (Campina Grande, Paraíba), properly pounded to break up clods, with the following physico-chemical characteristics: Sand = 528.5 g kg^{-1}; Silt = 202.0 g kg^{-1}; Clay = 269.5 g kg^{-1}; Total porosity = 57.93 m^3m^{-3}; Available water = 9.13 dag kg^{-1}; Apparent density = 1.14kg dm^{-3}; $pH_{(1:2.5)}$ = 5.10; EC_{se} = 0.2dS m^{-1}; OM = 1.27dag kg^{-1}; P = 20.05 mg kg^{-1}; K^+ = 0.07 $cmol_c kg^{-1}$; Na^+ = 0.38 $cmol_c$ kg^{-1}; Ca^{+2}= 1.52 $cmol_c kg^{-1}$; Mg^{+2} = 1.95 $cmol_c kg^{-1}$; Al^{+3} = 0.40 $cmol_c kg^{-1}$and H^+= 7.78 $cmol_c kg^{-1}$. The analyses were performed according to the methodologies proposed by Claessen (1997).

The experiment was conducted using the colored cotton cultivar 'BRS Topázio'. With a light brown fiber, 'BRS Topázio' stands out for having high fiber percentage (43.5%), high uniformity (85.2%) and high resistance (31.9 gf/tex), providing excellent characteristics, comparable to white-fiber cultivars and the other cultivars with colored fiber. The mean yield achieved by 'BRS Topázio', under irrigated cultivation, was 2,825 kg ha^{-1} (EMBRAPA, 2011).Before sowing, soil moisture content was elevated to field capacity in all lysimeters using saline water. Then sowing, irrigation was daily performed by applying in each lysimeter a volume of water to maintain soil moisture close to field capacity. The applied volume was determined according to crop water demand, estimated by the water balance: applied volume minus the volume drained in the previous irrigation. In order to avoid the accumulation of salts in the root zone, a leaching fraction equivalent to 0.10 was applied every 15 days (Ayers & Westcot, 1999).Eight seeds of cotton, cv. 'BRS Topázio', were sown in each lysimeter at a depth of 2 cm and distributed equidistantly. At 15 and 25 days after sowing (DAS), thinning was performed in order to leave only one plant per lysimeter.
Basal fertilization with phosphorus was performed based on the methodology described in Novais *et al*. (1991), through the application of the equivalent to 300 mg of P_2O_5 kg^{-1} of soil through superphosphate simple. Calcium nitrate was used as source of NO_3^-, ammonium chloride for NH_4^+ and potassium chloride for K^+. Fertilizations with different proportions of NO_3^- and NH_4^+ and K doses were divided; one third was applied at 15 DAS and the rest in three equal applications, at intervals of fifteen days, along with the saline water, and the first application occurred at 30 DAS. In order to avoid nitrification of the ammoniacal N, a nitrification inhibitor (Dicyandiamide) was applied along with each application of ammonium chloride, added at the dose of 10% in relation to the total NH_4^+-N used.

The growth of 'BRS Topázio' cotton was evaluated at 140 DAS through plant height (PH), stem diameter (SD) and leaf area (LA). Plant height was obtained considering the distance between the base of the plant and the insertion of the apical meristem. Stem diameter was measured at 5 cm from the base of the plant. Leaf area was obtained by measuring the midrib length of all leaves of the plants, based on the methodology described by Grimes & Carter (1969), according to Eq.1:

$$\mathrm{LA} = 0.26622\,L^{2.3002} \quad (1)$$

Where: LA is leaf area and L is the midrib length of the cotton leaf; leaf area plant^{-1} was determined by the sum of the leaf area of all the leaves. Cotton bolls were harvested at 150 DAS. Seed cotton samples of each plot were analysed in the Laboratory of Fibers and Threads of the EMBRAPA Cotton, for ginning and evaluation of the following technological characteristics of the fiber: length uniformity (UI); short fiber content (SFC); fiber resistance (SRT), fiber elongation (ELG) and count strength product (CSP), according to the methodology proposed by Santana *et al*. (1998).The collected data were subjected to analysis of variance by F test; when significant, regression analysis was performed for the factor K doses and a test of grouping of means (Scott-Knott at 0.05 probability level) was applied for the proportions of nitrate/ammonium, using the statistical software SISVAR-ESAL (Ferreira, 2011).

RESULTS AND DISCUSSION

The interactive effect of K doses and the proportions of NO_3^-/$NH_4^+$was significant ($p<0.05$) for all the analyzed variables of 'BRS Topázio' cotton, except for the number of leaves and lint weight, which were influenced only by the proportions of NO_3^-/NH_4^+, and fiber maturity, which was not affected ($p>0.05$) by the studied factors (Tables 1 and 2 and Figure 1).

recommendation, resulting in values 10.2 and 20.5% higher than those observed at the dose of 50%. Knowing that ionic N forms cause complex effects on plant growth and metabolism, leading to positive and/or negative physiological responses, the absorption of N predominantly in the form of NO_3^- requires large consumption of reducing equivalents for its conversion to NH_4^+, and later incorporation in organic compounds, generating an excessive expenditure of energy, limiting plant growth (Masclaux-Daubresse *et al*., 2010; Guo *et al*., 2012; Bartelheimer & Poschlod, 2013). Such expenditure may have been intensified in the present study, due to the salt stress conditions to which plants were subjected.

At the proportion of 50/50 mg of NO_3^-/NH_4^+, cotton leaf area responded quadratically to the different doses of K, with highest value of 1.92 m^2 in plants that received the doseequivalent to 100% recommendation. However, when plants were fertilized with proportions of 25/75 mg of NO_3^-/NH_4^+, there was a decreasing linear behavior of leaf area with reductions of the order of 0.25 m^2 for every increment of25% in the doses of K_2O (Table 1). Considering what the plants of 'BRS Topázio' cotton were cultivated under salt stress, and what the accumulation of soluble salts and/or sodium promoting adverse effects on plant growth, including osmotic disorders, which restricts the absorption of water by the roots,

Table 1. Plant height (PH), stem diameter (SD) and leaf area (LA) of cotton, cv. 'BRS Topázio', cultivated under salt stress and fertilized with different doses of potassium and proportions of nitrate and ammonium

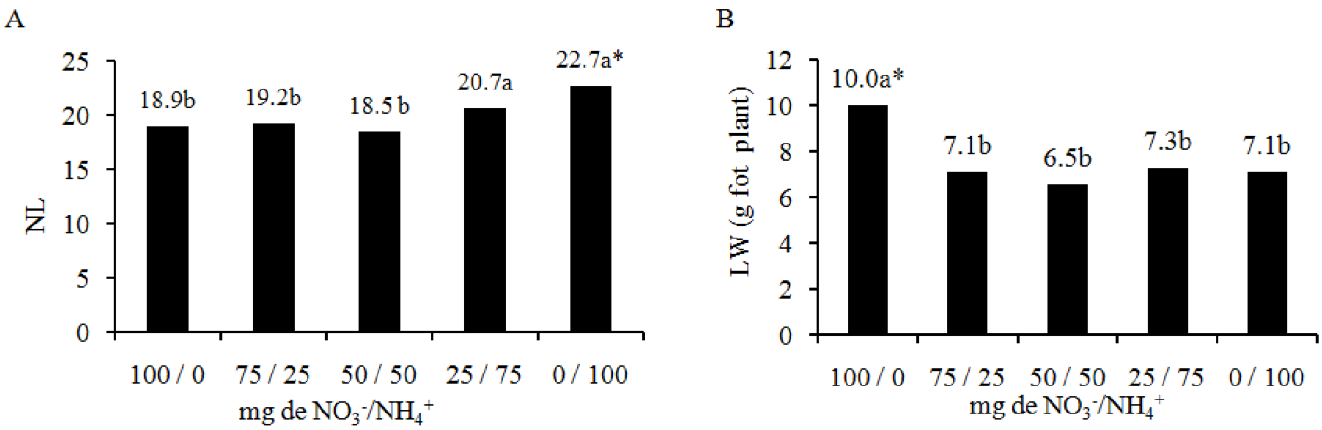
mg of NO_3^-/NH_4^+	% Recommendation of K_2O					Equation	R^2
	50	75	100	125	150		
	Plant height – PH (cm)						
100 / 0	53.2 a	48.8 b	55.1 a	50.2 b	49.8 b	NSF	---
75 / 25	54.3 a	59.2 a	53.2 a	49.8 b	55.2 b	NSF	---
50 / 50	53.7 a	51.5 a	55.4 a	58.4 a	55.8 b	NSF	---
25 / 75	57.7 a	59.0 a	55.5 a	56.8 a	51.5 b	NSF	---
0 / 100	53.0 a	56.4 a	61.8 a	58.6 a	65.1 a	$\hat{y} = 48.38 + 0.1057^{**}x$	0.79
	Stem diameter – SD (mm)						
100 / 0	8.4 b	7.5 a	8.3 a	8.5 a	8.0 b	NSF	---
75 / 25	8.0 b	8.5 a	8.4 a	7.8 a	8.3 b	NSF	---
50 / 50	8.7 a	8.1 a	8.0 a	8.4 a	8.1 b	NSF	---
25 / 75	9.2 a	9.0 a	8.5 a	8.5 a	8.7 b	NSF	---
0 / 100	7.7 b	8.3 a	8.9 a	8.7 a	9.5 a	$\hat{y} = 7.0207 + 0.0161^{**}x$	0.90
	Leaf area– LA (m^2)						
100 / 0	1.58 b	1.13 a	1.42 a	1.16 a	1.35 a	NSF	---
75 / 25	1.52 b	1.55 a	1.49 a	1.58 a	1.66 a	NSF	---
50 / 50	1.15 b	1.80 a	1.84 a	1.69 a	1.12 a	$\hat{y} = - 1.0613 + 0.0598^{NS}x - 0.0003^{*}x^2$	0.98
25 / 75	2.30 a	1.73 a	1.67 a	1.59 a	1.13 a	$\hat{y} = 2.6769 - 0.0099^{**}x$	0.88
0 / 100	1.51 b	1.48 a	1.60 a	1.71 a	1.56 a	NSF	---

** and * = significant at 0.01 and 0.05 probability level, respectively. NSF = non-significant fit. Means followed by same letters in the column do not differ by the Scott-Knott test, $p<0.05$.

'BRS Topázio' cotton plants fertilized with higher proportions of NH_4^+ attained higher growth in height, stem diameter and leaf area, with more evident responses of K^+ doses higher than 100% of the recommendation (Table 1). However, the growth in height and stem diameter of 'BRS Topázio' cotton was not influenced by the K^+ doses when subjected to fertilization with other proportions. In spite of that, there was an increasing linear behavior of the variables when plants were fertilized with 0/100 mg of N in the form of NO_3^-/NH_4^+, with increments of 0.1057 cm and 0.0161 mm per unit increase in K^+ doses (Table 1), achieving59.2 cm of height and 9.4 mm of stem diameter when fertilized with 150% of the K_2O

toxicity by ions (especially Na^+ and Cl^-) and nutritional imbalance (Muns & Tester, 2008; Oliveira *et al*., 2012; Almeida *et al*., 2015; Araújo *et al*., 2015; Sá *et al*., 2015). On the other hand, the absence of positive response of the increasing K doses when associated with nitrate fertilization can be related to the absence of competition between these ions and, between them and Na^+ and Cl^-; thus, lower doses of potassium are able to meet the nutritional needs of the crop, because the absorption of nitrate favors the assimilation of K^+ (Brandão *et al*., 2012). However, when N is applied in the ammoniacal form, it competes with both Na^+ and K^+. Hence, the higher leaf area observed in plants subjected to the lowest

K_2O doses or to the intermediate ones indicates that the interaction potassium x ammonium at adequate doses mitigates the effect of salt stress in cotton plants. However, high doses of K_2O associated with N fertilization with greater proportions of ammonium in a salinized environment intensified the effect of salt stress on cotton plants, reducing leaf expansion (Table 1). The positive response of N fertilization with greater proportions of ammonium in relation to nitrate also reflected in the number of leaves of cotton plants, and the highest leaf production (on average, 22.7 leaves) was obtained with fertilization exclusively in the ammoniacal form (Figure 1A). Thus, the reductions in leaf area observed in treatments with greater proportions of ammonium in relation to nitrate may be related to the mechanisms of tolerance of the species to salt stress, because, for fertilizations with greater proportions of ammonium, there was higher production of leaves, but with smaller size, which must be related to the tolerance mechanism to reduce water loss through transpiration, in order to maintain cell turgor potential and minimize the absorption of water and, consequently, of salts. Although the highest growth of cotton cv.'BRS Topázio' was observed when N fertilization contained greater proportions of NH_4^+, the highest lint weight (LW) was



*Means followed by same letters do not differ by the Scott-Knott testat p<0.05.

Figure 1. Number of leaves-NLat 140 days after sowing (A) and lint weight-LW (B) of 'BRS Topázio' cotton cultivated under salt stress and different proportions of nitrate/ammonium

Table 2. Uniformity (UI), short fiber content (SFC), resistance (SRT), breaking elongation (ELG) and count strength product (CSP) of the fiber of 'BRS Topázio' cotton cultivated under salt stress and fertilized with different doses of potassium and proportions of nitrate and ammonium

mg de NO_3^-/NH_4^+	% Recommendation of K_2O					Equations	R^2
	50	75	100	125	150		
			Uniformity – UI (%)				
100 / 0	92.3 a	84.9 a	85.4 a	83.5 b	84.0 a	$\hat{y} = 124.46*x^{-0.082}$	0.76
75 / 25	85.3 b	84.7 a	85.8 a	87.3 a	85.1 a	NSF	---
50 / 50	86.2 b	84.8 a	85.8 a	85.3 a	82.9 a	NSF	---
25 / 75	83.7 b	83.5 a	85.6 a	85.7 a	85.4 a	NSF	---
0 / 100	84.2 b	85.6 a	82.8 a	84.1 b	85.8 a	NSF	---
			Short fiber content - SFC				
100/0	7.3 a	7.6 a	7.2 b	8.5 a	7.8 b	NSF	---
75 / 25	7.3 a	7.7 a	6.4 b	6.2 b	7.7 b	NSF	---
50 / 50	7.2 a	7.7 a	7.3 b	7.6 b	9.0 a	NSF	---
25 / 75	8.1 a	8.5 a	7.2 b	6.9 b	7.0 b	NSF	---
0 / 100	7.6 a	7.6 a	9.7 a	9.3 a	7.5 b	$\hat{y} = 1.5918 + 0.1462^{NS}x - 0.0007*x^2$	0.64
			Resistaci – SRT (gf tex^{-1})				
100 / 0	29.3 b	29.9 a	31.2 a	28.2 c	28.6 b	NSF	---
75 / 25	30.5 b	29.2 a	32.3 a	34.4 a	33.2 a	NSF	---
50 / 50	32.7 a	29.3 a	30.3 b	27.3 c	26.8 b	$\hat{y} = 34.846 - 0.0555**x$	0.84
25 / 75	29.1 b	28.3 a	29.6 b	31.8 b	31.0 a	NSF	---
0 / 100	28.1 c	28.4 a	27.7 c	29.9 c	27.8 b	NSF	---
			Elongation at break – ELG (%)				
100 / 0	5.6 a	6.7 a	6.1 a	5.7 a	6.0 a	NSF	---
75 / 25	5.2 a	5.7 b	5.8 a	5.4 a	5.7 a	NSF	---
50 / 50	5.6 a	5.6 b	5.9 a	5.8 a	5.0 b	$\hat{y} = 4.0412 + 0.0412^{NS}x - 0.00025*x^2$	0.82
25 / 75	5.6 a	5.4 b	5.7 a	5.4 a	5.6 b	NSF	---
0 / 100	5.0 a	5.4 b	5.3 a	5.9 a	5.0 b	NSF	---
			Count strength product–CSP				
100 / 0	3883 a	2619 a	2694 a	2536 b	3450 a	NSF	---
75 / 25	2967 b	2679 a	2711 a	3313 a	3043 b	NSF	---
50 / 50	3180 b	3080 a	2711 a	2620 b	2534 c	$\hat{y} = 3525.3 - 7.0042**x$	0.93
25 / 75	2588 b	2576 a	2840 a	2899 b	2704 c	NSF	---
0 / 100	2843 b	2800 a	2463 a	2757 b	2555 c	NSF	---

** and * = not significant, significantat 0.01 and 0.05 probability level, respectively. NSF = non-significant fit. Means followed by same letters in the column do not differ by the Scott-Knott at p<0.05

obtained under N fertilizations with 100/0 mg of NO_3^-/NH_4^+ (Figure 1B). As observed for LW, the highest values referring to the technological characteristics of the cotton fiber were also observed in plants that received fertilizations with greater proportions of N in the nitric form, especially when this fertilization was associated with the doses of 50 and 75% of the recommendation of K (Table 2). These results indicate that positive responses of N fertilization with nitrate and ammonium differ between the vegetative and yield formation (reproductive) stages of the cotton crop, with positive responses of ammonium, especially in the vegetative stage, and nitrate, in the yield formation stage.The assimilation of N in the form of NH_4^+ demands lower amount of energy, because it dispenses the reduction stages, which are required when there is absorption of N-NO_3^-(Hachiya *et al*., 2012). Thus, this reduction in the expenditure of energy probably favored higher growth of cotton plants. However, the excessive absorption of NH_4^+ can be cytotoxic, causing chlorosis and alteration in the pH of the cytosol, besides reduction of growth and, consequently, of production (Guimarães *et al*., 2014).

Therefore, the negative effects of the continuous absorption of NH_4^+ reflected only in the production stage, probably because of excess of this cation in the plant, or the lower functionality of plant metabolism under salt stress conditions.The increase in K doses negatively affected fiber uniformity when associated with the proportion with 100 mg of nitrate. Under this condition, there was a potential reduction in fiber uniformity from 90.3%, at the dose of 50% of the K_2O recommendation, to 82.5% in plants subjected to 150% of the recommendation. At the other proportions, there was no significant difference of potassium doses (Table 2). However, for upland cotton, the reference of quality of UI is at least 83% (Encher *et al*., 2009); thus, the plants produced fibers with acceptable uniformity in all treatments.There was no significant fit of the K doses for shortfiber content when cotton plants were fertilized with proportions of 100/0, 75/25, 50/50 and 25/75 mg of NO_3^-/NH_4^+. However, when plants were fertilized with 0/100 mg NO_3^-/NH_4^+, there was a quadratic behavior of the short fiber content as a function of the K doses, with highest value (9.22) at the estimated K^+ dose of 104% of the recommendation of K_2O (Table 2).

There was significant influence of K doses only at the proportion of 50/50 mg of NO_3^-/NH_4^+, with linear reductions in resistance and count strength product, equivalent to 1.38 (gf tex^{-1}) and 175.10 for every increment of 25% in the K dose (Table 2). In general, it can be observed that the means of resistance and count strength product decreased with the increase in the proportions of ammonium, regardless of the K dose (Table 2). On the other hand, the breaking elongation under the same condition responded quadratically to the increment in K doses, with maximum value of 5.7% at the estimated dose of 82.4% of the K_2O recommendation (Table 2). According to Santana *et al*. (1998), the desirable industrial characteristics for some of the evaluated attributes are: resistance above 28.5 gf tex^{-1}; short fiber content below 9%; and count strength product above 2,200; thus, only the treatments with 0/100 mg of NO_3^-/NH_4^+ did not show desirable industrial characteristics.Fertilization with 50/50 mg of NO_3^-/NH_4^+ associated with 50% of the K recommendation promoted satisfactory industrial indices in all fiber quality characteristics of ‘BRS Topázio’ cotton (Table 2), even under salt stress conditions (ECw of 6.0 dSm^{-1}). Thus, it can be inferred that the increment in the proportions of N in the form of NH_4^+ reduced the quality of the fibers of ‘BRS Topázio’ cotton, especially under higher K_2O doses (Table 2). The negative effects of NH_4^+ are associated with the acidification of the rhizosphere, lower absorption of other cations (competition for NH_4^+) and hormonal imbalance (Roosta & Schjoerring, 2007; Hachiya *et al*., 2012). The increase in NH_4^+ concentration probably promoted an antagonistic effect on K absorption, especially due to the excess of salts from the irrigation water, causing them to remain in the soil solution and the environment to become more saline.In addition, the restriction of K^+ also contributes to affect crop yield, since K in the plant acts structurally in the composition of important biomolecules and in the metabolism as enzymatic activator and regulator of osmotic pressure (inlet and outlet of water in the cell) (Encher *et al*., 2009; Ferrari *et al*., 2012; Kaneko *et al*., 2014).

The results observed in the present study confirm the claim of Epstian & Bloom (2006), who stated that the nutritional imbalance stood out in relation to the other deleterious effects caused by the salt stress, promoting disorders in growth and production. Under salt stress conditions, the absorption of nutrients may vary in relation to the cultivation under conditions of low salinity, where the nutrients required in highest amounts by cotton are N and K (Ferrari *et al*., 2012; Kaneko *et al*., 2014; Barcelos *et al*., 2016). Therefore, under low salinity conditions, fertilization with nitrate can compete with the reduction of CO_2, increasing the photorespiration rate (Encher *et al*., 2009); however, under high salinity conditions, nitrate may help the absorption of K^+ and reduce toxicity, due to the excessive absorption of ammonium (Epstian& Bloom, 2006; Hachiya *et al*., 2012), resulting in increment of lint weight and improving the technological characteristics of the cotton fiber, even under salt stress conditions.

Conclusions

- There is significant interactive effect of the K^+doses and proportions of nitrate/ammonium on growth and technological characteristics of the fiber of ‘BRS Topázio’ cotton cultivated under saline stress.
- Fertilization with 50/50 mg of nitrate/ammonium, along with 50% K recommendation, favors growth, production and fiber quality of colored cotton, cv. ‘BRS Topázio’.

REFERENCE

Almeida LLS, Nobre RG, Souza LP, Barbosa JL, Elias JJ. 2015. Crescimento do algodoeiro colorido pós-poda em solos com distintas PSTs e doses de esterco. Revista Verde de Agroecologia e Desenvolvimento Sustentável,10: 06-11.

Araújo JL, Severo PJS, Lucena FT, Veriato RG, Paiva KF. 2015. Enxofre elementar ou sulfato de cálcio para remediação de solos salino-sódicos? Pesquisa Agropecuária Tropical, 45: 388-396.

Ayers RS, Westcot DW. 1999. Qualidade da água na agricultura. 2. ed. Campina Grande: UFPB. 153p. Estudos FAO: Irrigação e Drenagem, 29.

Barcelos JPQ, Furlani Junior E, Reis HPG, Putti FF, Reis AR. 2016. Diagnóstico da exigência do algodoeiro em nitrogênio e níquel pela utilização do medidor portátil de clorofila. Brazilian Journal of Biosystems Engineering, 10: 97-106.

Bartelheimer M, Poschlod P. 2013. The response of grassland species to nitrate versus ammonium coincides with their pH optima. Journal of Vegetation Science, 25: 01-11.

Brandão ZN, Ferreira GB,Sofiatti V, Lima RLS, Medeiros JC. 2012. Uso de nitrogênio e fósforo e seus efeitos na nutrição do algodoeiro irrigado. Revista Brasileira de Ciências Agrárias, 7: 213-218.

Claessen MEC. 1997. Manual de métodos de análise de solo. 2.ed. rev. atual. Rio de Janeiro: EmbrapaCNPS. 212p. (EmbrapaCNPS. Documentos, 1).

CONAB. Companhia Nacional de Abastecimento. Acompanhamento da safra brasileira de grãos. V.3 - Safra 2015/16 N.1 – Primeiro levantamento – Intenção de plantio Outubro/2015. 129p.

Echer FR, Foloni JSS, Creste JE. 2009.Fontes de potássio na adubação de cobertura do algodoeiro I – Produtividade, qualidade de fibras e análise econômica. Semina: Ciências Agrárias, 30: 1135-1144.

EMBRAPA. Empresa Brasileira de Pesquisa Agropecuária. Centro Nacional de Pesquisa de Algodão (Campina Grande, PB). Algodão colorido: "Tecnologia Embrapa para a geração de emprego e renda na agricultura familiar do Brasil''. Campina Grande, 2011. 2p. (EMBRAPA-CNPA, Circular Técnico, 17).

Epstein E, Bloom AJ. 2006.Nutrição mineral de plantas: princípios e perspectivas. 2.ed. Londrina: Planta. 403p.

Ferrari S,Furlani Júnior E, Ferrari JV, Alberton JV. 2012. Plantas de cobertura e adubação nitrogenada na cultura do algodoeiro. Revista Brasileira de Ciências Agrárias, 7: 226-232.

Ferreira DF. 2011. Sisvar: a computer statistical analysis system. Ciência e Agrotecnologia, 35: 1039-1042.

Freitas RJ, Leandro WM, Carvalho MCS. 2007. Efeito da adubação potássica via solo e foliar sobre a produção e a qualidade da fibra em algodoeiro (*Gossypium hirsutum* L.). Pesquisa Agropecuária Tropical, 37: 106-112.

Grimes DW, Carter LM. 1969. A linear rule for direct non destructive leaf area measurements. Agronomy Journal, 3: 477-479.

Guimarães MMC, Cairo PAR, Neves OSC. 2014. Crescimento de *Eucalyptus urophylla* em meio hidropônico com diferentes proporções de nitrato e amônio. Floresta e Ambiente, v. 21: 52-61.

Guo XR, Zu YG, Tang ZH. 2012. Physiological responses of *Catharanthus roseus* to different nitrogen forms. Acta Physiologiae Plantarum, 34: 589-598.

Hachiya T, Watanabe CK, Fujimoto M, Ishikawa T, Takahara K, Kawai-Yamada M, Uchimiya H, Uesono Y, Terashima I, Noguchi K. 2012. Nitrate addition alleviates ammonium toxicity without lessening ammonium accumulation, organic acid depletion and inorganic cation depletion in A*rabidopsis thaliana* shoots. Plant and Cell Physiology, 53: 577-591.

Kaneko FH, Leal AJF, Dias AR, Anselmo JL, Buzetti S, Bem EAD, Gitti DC,Nascimento V. 2014. Resposta do algodoeiro em cultivo adensado a doses de nitrogênio, fósforo e potássio. Revista Agrarian, 7: 382-389.

Mao L, Zhang L, Evers JB, Wopke W, Liu S, Zhang S, Wang B, Li Z. 2015. Yield components and quality of intercropped cotton in response to mepiquat chloride and plant density. Field Crops Research, 179: 63-71.

Masclaux-Daubresse C, Daniel-Vedele F, Dechorgnat J, Chardon F, Gaufichon L, Suzuki A. 2010. Nitrogen uptake, assimilation and remobilization in plants: hallenges for sustainable and productive agriculture. Annals of Botany, 105: 1141-1157.

Medeiros JF, Lisboa RA, Oliveira M. 2003. Caracterização das águas subterrâneas usadas para irrigação na área produtora de melão da Chapada do Apodi. Revista Brasileira de Engenharia Agrícola e Ambiental, 7: 469-472.

Munns R,Tester M.2008. Mechanisms of salinity tolerance. Annual Review of Plant Biology, 59: 651-681.

Novais RF, Neves JCL, Barros NF.1991. Ensaio em ambiente controlado. In: Oliveira A. J. (ed.) Métodos de pesquisa em fertilidade do solo. Brasília: Embrapa-SEA. p.189-253.

Oliveira FA, Medeiros JF, Oliveira FRA, Freire AG, Soares LCS. 2012. Produção do algodoeiro em função da salinidade e tratamento de sementes com regulador de crescimento. Revista Ciência Agronômica, 43: 279-287.

Roosta HR, Schjoerring JK. 2007.Effects of ammonium toxicity on nitrogen metabolism and elemental profile of cucumber plants. Journal of Plant Nutrition, 30: 1933-1951.

Sá FVS, Mesquita EF, Bertino AMP, Costa JD, AraújoJL. 2015. Influência do gesso e biofertilizante nos atributos químicos de um solo salino-sódico e no crescimento inicial do girassol. Irriga, 20: 46-59.

Santana JCF,Vanderley MJR, Beltrão NEM, Vieira DJ. 1999. Características da fibra e do fio do algodão: Análise e interpretação dos resultados. In: Beltrão NEM (ed.) O agronegócio do algodão no Brasil. Brasília: Embrapa Comunicação para Transferência de Tecnologia, Cap.29, p.857-880.

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