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Scientific Article

Combinations of nitrogen and potassium fertilization in the cultivation of cotton genotypes

Combinações de adubação nitrogenada e potássica no cultivo de genótipos de algodoeiro

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ABSTRACT - In semi-arid regions, characterized by low soil fertility, it is essential to ensure an adequate proportion of nutrients to maximize cotton production, with emphasis on nitrogen and potassium, which are the main nutrients required by this crop. Therefore, the objective of the present study was to evaluate the effect of different combinations of nitrogen and potassium doses on the biomass and production components of colored cotton genotypes. The experiment was carried out in pots under field conditions, in a randomized block design, with treatments arranged in a 3 × 5 factorial scheme, with three genotypes of colored fiber cotton (‘BRS Rubi’, ‘BRS Jade’, and ‘BRS Safira’) and five combinations of nitrogen and potassium fertilization - N:K (50:125; 75:100; 100:100; 100:75, and 125:50% of the recommendation), with the combination of 100:100% of the recommendation corresponding to 100 mg of N and 150 mg of K_2O kg^{-1} of soil, with four replicates and one plant per plot. Photosynthetic pigments, growth, and production components of colored fiber cotton genotypes were measured. The interaction between the ‘BRS Rubi’ genotype and the combination of 100:75% N:K fertilization promoted the highest dry mass accumulation and fiber percentage. For the production of bolls with greater weight, the ‘BRS Jade’ genotype stood out in comparison with the others, regardless of the fertilizer combination, while ‘BRS Safira’ produced greater seed weight with the 125:50% N:K fertilizer combination.

Keywords: *Gossypium hirsutum* L.. Natural colored fiber. Nutritional management.

RESUMO - Em regiões semiáridas, caracterizadas pela baixa fertilidade dos solos, é essencial garantir uma proporção adequada de nutrientes para maximizar a produção do algodoeiro, com destaque para o nitrogênio e o potássio que são os principais nutrientes requeridos por essa cultura. Diante disso, foi estudado o efeito de combinações de adubação nitrogenada e potássica sobre pigmentos cloroplastídicos, fitomassas e componentes de produção de genótipos de algodoeiro de fibra colorida. O experimento foi realizado em vasos sob condição de campo, em delineamento de blocos ao acaso, com tratamentos dispostos em esquema fatorial 3 × 5, sendo três genótipos de algodoeiro de fibra colorida (BRS Rubi, BRS Jade e BRS Safira) e cinco combinações de adubação nitrogenada e potássica - N:K (50:125; 75:100; 100:100; 100:75 e 125:50% da recomendação) sendo a combinação de 100:100% da recomendação correspondendo a 100 mg de N e 150 mg de K_2O kg^{-1} do solo, com quatro repetições e uma planta por parcela. Neste estudo foram mensurados os pigmentos fotossintéticos, o crescimento e os componentes de produção dos genótipos de algodoeiro de fibra colorida. A interação entre o genótipo ‘BRS Rubi’ com a combinação da adubação de 100:75% N:K proporcionou o maior acúmulo de fitomassa seca e porcentagem de fibra. Para produção de capulho com maior peso, o genótipo ‘BRS Jade’ se destacou dos demais, independentemente da combinação de adubação, enquanto, o genótipo ‘BRS Safira’ produziu maior peso de sementes com a combinação de adubação 125:50% N:K.

Palavras-chave: *Gossypium hirsutum* L.. Fibra colorida natural. Manejo nutricional.

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INTRODUCTION

Cotton cultivation is of great socioeconomic importance to Brazil, as it is one of the main fiber and oil producing crops, occupying large production areas, with a significant demand for labor in several states of the country (DIAS et al., 2020). In 2021, Brazil had a herbaceous cotton harvested area of 1,369,562 hectares and a production of 5,712,308 tons of seed cotton, of which only 2,014 tons are produced in the state of Paraíba (IBGE, 2021).

Several factors are responsible for this reduction in cotton production in terms of quality and quantity in the state of Paraíba, especially inadequate mineral fertilization, including nitrogen and potassium fertilization (MROJINSKI et al., 2020). In this context, the correct dose of these nutrients is essential to promote optimal plant growth, development and production, avoiding nutritional deficiencies, economic loss, and problems with salinization and environmental pollution associated with excessive chemical fertilization (TAVARES; BELTRÃO, 2020).

Adequate nitrogen fertilization in cotton cultivation can improve plant growth, flowering, and yield, as nitrogen acts on the enzyme system, being an essential component of Ribulose 1,5-biphosphate carboxylase/oxygenase (RuBisCO), a key enzyme for carbon fixation, participating in several physiological processes directly related to cell expansion and division (LIMA et al., 2017; SNIDER et al., 2021). On the other hand, excess nitrogen can cause exaggerated vegetative growth and cycle retardation, compromising boll production and quality (LEAL et al., 2020).

Potassium plays multiple metabolic roles in cotton, influencing the synthesis of carbohydrates and proteins, phosphorylation reaction, respiration, in addition to acting directly on the opening and closing of stomata and translocation of water and nutrients by xylem and photoassimilates that are allocated to various organs of the plant (DIAS et al., 2021; FERREIRA et al., 2022). It is also responsible for the conversion of starch into sugars, directly affecting cotton production through boll weight and fiber quality (HU et al., 2016).

However, inadequate potassium doses trigger detrimental effects on plants, as it competes with other nutrients for absorption, such as NH_4^+, Mg^{2+} and Ca^{2+}, or leading to shortening of the cotton production cycle, resulting in an early fruit maturation, hence compromising fiber production and quality (WANG et al., 2012; SILVA et al., 2022). Thus, the application of nitrogen and its balanced relative proportion with potassium constitute a fundamental factor for cotton production (ARAÚJO et al., 2022), also considering that potassium is the main activator of the nitrate reductase enzyme, involved in the reduction of nitrogen in the form of nitrate to nitrite in the cytosol (SOARES et al., 2020).

Despite the knowledge on the importance of nitrogen and potassium fertilization, cotton genotypes do not respond equally to fertilization and can genetically express differently according to their peculiarities and yield potential (DIAS et al., 2020). In this context, the objective of this study was to evaluate combinations of nitrogen and potassium fertilization on chloroplast pigments, biomass, and production components of colored fiber cotton genotypes.

MATERIAL AND METHODS

The experiment was carried out in pots under field conditions, at the Center of Sciences and Agrifood Technology (CCTA) of the Federal University of Campina Grande (UFCG), located in Pombal, Paraíba, Brazil, at geographic coordinates 6°46'13" South, 37°48'6" West, and average altitude of 184 m. The meteorological data recorded during the experiment from February 11, 2020 to June 9, 2020 are presented in Figure 1.

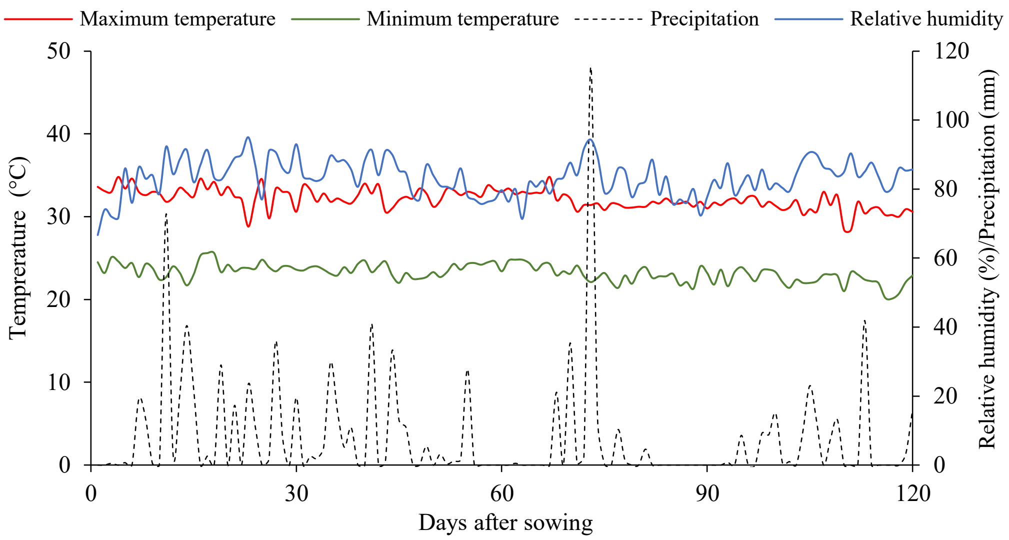


Figure 1. Climate data of maximum temperature, minimum temperature, precipitation, and relative humidity during the experimental period (February 11, 2020 to June 09, 2020).

The experimental design was randomized blocks, and the treatments were arranged in a 3 × 5 factorial scheme, with four replicates, totaling 60 experimental plots, each plot consisting of a 20 L container with one plant. The factors consisted of three genotypes of colored fiber cotton ('BRS Rubi', 'BRS Jade', and 'BRS Safira') and five combinations of nitrogen and potassium - N:K (50:125, 75:100, 100:100, 100:75, and 125:50% of the recommendation of Novais, Neves and Barros (1991)), with the combination of 100:100% (control) corresponding to 100 mg of N and 150 mg of K_2O kg^{-1} of soil.

The treatments were defined to evaluate the combined action of N:K on naturally colored fiber cotton genotypes. These factors are usually studied separately, since nitrogen and potassium are required in greater quantities by crops and are essential for growth, physiology, phytosanitary status, and production, since plant nutrition is related to the quality of the final product (MALTA et al., 2019). The colored cotton genotypes 'BRS Rubi', 'BRS Jade', and 'BRS Safira', developed by Embrapa Cotton, produce fiber with quality and yield similar to or superior to those of white fiber genotypes, with an additional advantage of reducing the cost of the industry with dyes and environmental pollution (EMBRAPA, 2011).

Cotton plants were grown in 20 L plastic containers, which were filled with a 3-cm-thick layer of crushed stone and covered with polypropylene screen, to avoid clogging of the drain by soil material. At the base of each container, a 15-mm-diameter tube was installed as a drain, coupled to a plastic container (2 L) for collection of drained water and determination of the water consumed and calculation of necessary irrigation depth to be applied in next irrigation event. Then, the containers received *Neossolo Flúvico* (Fluvent) of sandy loam texture, collected at 0-30 cm depth from an agricultural area in the municipality of Pombal, PB, which was previously pounded to break up clods and sieved, whose physical and chemical characteristics were determined according to the methodology of Teixeira et al. (2017) (Table 1).

Table 1. Physical-hydraulic and chemical attributes of the soil used in the experiment.

Chemical characteristics								
pH (H_2O)	OM	P	K^+	Na^+	Ca^{2+}	Mg^{2+}	Al^{3+}	H^+
(1:2.5)	g kg^{-1}	(mg kg^{-1})	---------- $cmol_c$ kg^{-1} ----------					
5.58	2.93	39.2	0.23	1.64	9.07	2.78	0	8.61
Chemical characteristics				Physical characteristics				
EC_{se}	CEC	SAR_{se}	ESP	Particle-size fraction - g kg^{-1}			Moisture - dag kg^{-1}	
(dS m^{-1})	$cmol_c$ kg^{-1}	(mmol $L^{-1})^{0.5}$	%	Sand	Silt	Clay	33.42 kPa[1]	1519.5 kPa[2]
2.15	22.33	0.67	7.34	572.7	100.7	326.6	25.91	12.96

Determined attributes: pH – Hydrogen Potential, OM – Organic Matter: Walkley-Black Wet Digestion; Ca^{2+} and Mg^{2+} extracted with 1 M KCl pH 7.0; Na^+ and K^+ extracted with 1 M NH_4OAc at pH 7.0; $Al^{3+}+H^+$ extracted with 0.5 M CaOAc at pH 7.0; EC_{se} - Electrical conductivity of saturation extract; [1,2] referring to field capacity and permanent wilting point, respectively. Estimated attributes: CEC - Cation exchange capacity; SAR_{se} - Sodium adsorption ratio of saturation extract; ESP - Exchangeable sodium percentage.

Nitrogen and potassium fertilization was applied at 10, 20, 30, and 40 days after sowing (DAS) according to the recommendation for pot experiments contained in Novais, Neves and Barros (1991), using urea and potassium chloride as sources, applied respectively in the following combinations: C1 = 50:125% (3.12 g of N and 23.4 g of K_2O per plant), C2 = 75:100% (4.68 g of N and 18.72 g of K_2O per plant); C3 = 100:100% (6.24 g N and 18.72 g K_2O per plant); C4 = 100:75% (6.24 g N and 14.04 g K_2O per plant), and C5 = 125:50% (7.8 g N and 18.72 g K_2O per plant). Phosphate fertilization also followed the recommendation contained in Novais, Neves and Barros (1991), applying 300 mg of P_2O_5 kg^{-1} of soil in the form of monoammonium phosphate (MAP), split into four applications, starting at 15 days after sowing (DAS) and later every 20 days, all supplied as topdressing via irrigation water.

Five seeds of the cotton genotypes were sown in each container at 1.5 cm depth and distributed equidistantly. At 15 DAS, the first thinning was carried out, leaving only three plants per pot, selecting those with the best vigor. At 30 DAS, thinning was carried out again, maintaining one plant per pot. Irrigation depth to be applied was determined by water balance, keeping soil moisture at the level equivalent to the maximum retention capacity, in all experimental units, and the volume of water applied was determined according to the water requirement of the plants, according to Equation 1:

$$VC = \frac{VA - VD}{1 - LF} \quad (1)$$

Where:
VC - volume consumed (mL);
VA - volume of water applied to the plants on the previous day (mL);
VD - volume drained, quantified on the next day (mL), and;
LF - leaching fraction equivalent to 0.15 applied every 15 days to minimize the accumulation of salts in the root zone.

Pest and disease control was carried out with chemical pesticides, as needed, using a pre-compression manual sprayer, with tank made of high-molar-mass polyethylene, with a volumetric capacity of 5 L. Appearance and growth of spontaneous plants were controlled by manual weeding in order to avoid interspecific competition for light, water and nutrients.

At 120 DAS, chloroplast pigments were evaluated from chlorophyll *a* (Chl *a*), chlorophyll *b* (Chl *b*), chlorophyll *total* (Chl *total*) and carotenoids (Car) according to the methodology proposed by Arnon (1949), using 3 discs of plant tissue collected from the third leaf of a branch located in the median region of the crown. The collected material was immersed in 80% acetone and stored in the dark for 48 hours. The extracts obtained were subjected to readings in a spectrophotometer at absorbance wavelengths (ABS) of 470, 646, and 663 nm, and the contents were calculated using Equations 2, 3, 4 and 5, and results expressed in mg g^{-1} FM.

$$\text{Chl } a = 12.21 \text{ ABS663} - 2.81 \text{ ABS646} \quad (2)$$

$$\text{Chl } b = 20.13 \text{ ABS646} - 5.03 \text{ ABS663} \quad (3)$$

$$\text{Chl } total = 17.3 \text{ ABS646} + 7.18 \text{ ABS663} \quad (4)$$

$$\text{Car} = (1000 \text{ ABS470} - 1.82 \text{ Chl } a - 85.02 \text{ Chl } b)/198 \quad (5)$$

At the end of the crop cycle (120 DAS), the plants were collected, separated into leaves, stems, and roots, packed in properly identified paper bags, dried in an air circulation oven at 65 ºC for 48 hours, and then the material was weighed on a scale with precision of 0.001 g to obtain leaf dry mass (LDM), stem dry mass (StDM), and root dry mass (RDM). LDM and StDM were summed to obtain shoot dry mass (ShDM). Total dry mass (TDM) corresponded to the sum of

StDM + RDM. Leaf area ratio was calculated according to Benincasa (2003), using Equation 6:

$$\mathrm{LAR} = \frac{\mathrm{LA}}{\mathrm{TDM}} \quad (6)$$

Where:
LAR = leaf area ratio (cm^2 g^{-1} ShDM);
LA = leaf area (cm^2), and;
TDM = total dry mass (g per plant).

In this same period, the bolls were harvested per plant, and the following production components were quantified: boll weight (BW) and seed weight (SW), obtained on a scale with precision of 0.001 g. Fiber percentage (Fiber%) was determined according to the methodology of Albrecht et al. (2009), using Equation 7:

$$\mathrm{Fiber\%} = \frac{\mathrm{LCM}}{\mathrm{SCM}} \times 100 \quad (7)$$

Where:
Fiber% = fiber percentage (%);
LCM = lint cotton mass (g), and;
SCM = seed cotton mass (g).

The collected data were initially subjected to the distribution normality test (Shapiro-Wilk). Next, analysis of variance was performed (F test), and in cases of significant effect, Tukey test ($p \leq 0.05$) was performed to evaluate the combinations of nitrogen and potassium and cotton genotypes using the statistical software SISVAR – ESAL (FERREIRA, 2019).

RESULTS AND DISCUSSION

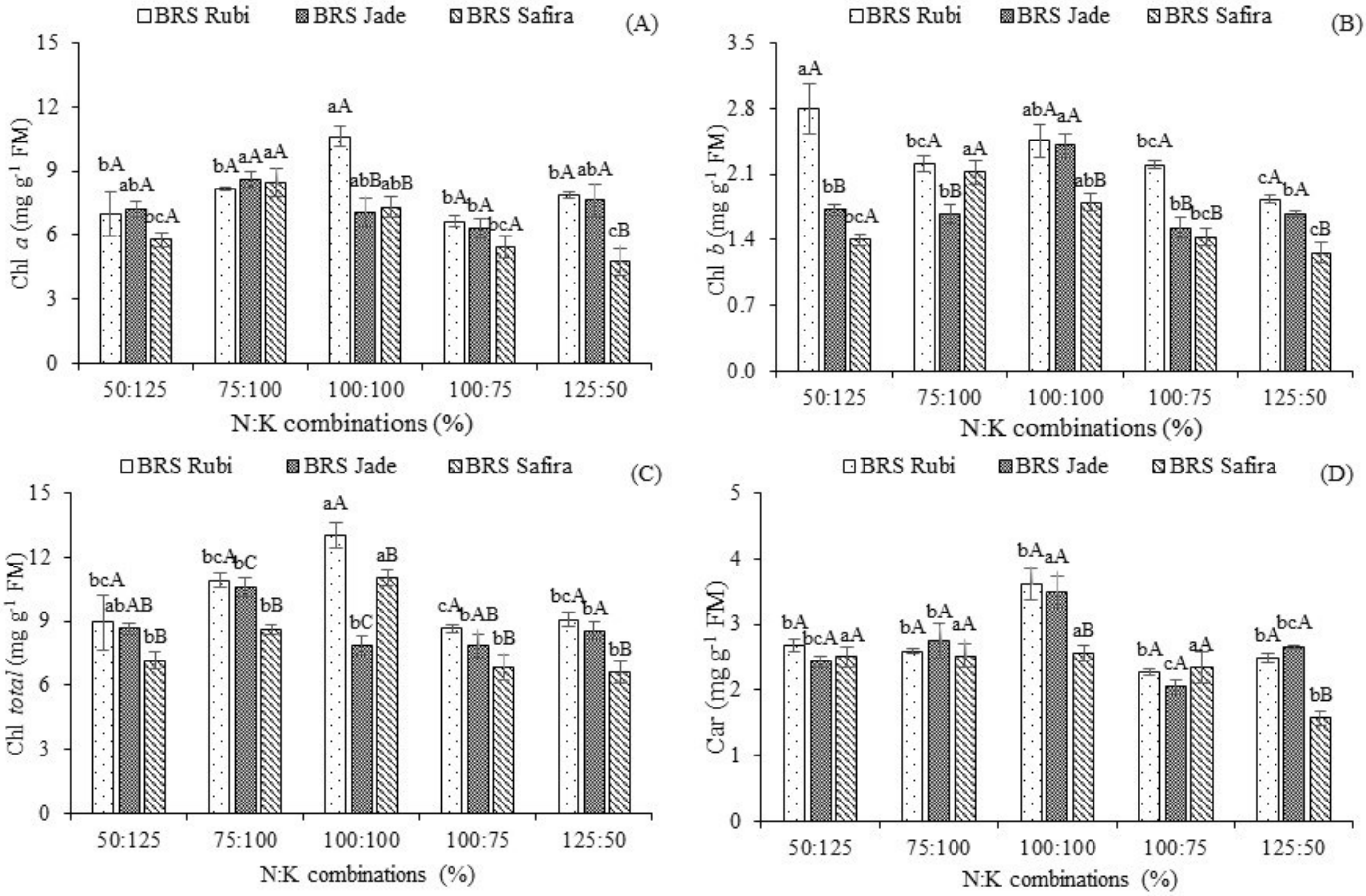
There was a significant interaction between the combinations of N:K fertilization and colored cotton genotypes (C × G) for chlorophyll *a* (Chl *a*), chlorophyll *b* (Chl *b*), chlorophyll *total* (Chl *total*), carotenoids (Car), dry mass of leaf (LDM), stem (StDM), shoot (ShDM), and root dry mass (RDM), fiber percentage (Fiber%), seed weight (SW), and boll weight (BW). Leaf area ratio (LAR) was affected ($p \leq 0.05$) only by the colored cotton genotypes (G) (Table 2).

Table 2. Summary of the analysis of variance for chlorophyll *a* (Chl *a*), chlorophyll *b* (Chl *b*), chlorophyll *total* (Chl *total*), carotenoids (Car), at 85 days after sowing (DAS) and dry mass of leaf (LDM), stem (StDM), shoot (ShDM), and root (RDM), leaf area ratio (LAR), fiber percentage (Fiber%), seed weight (SW), and boll weight (BW) of colored cotton genotypes subjected to the application of combinations of nitrogen and potassium fertilization (N:K) at 120 DAS.

Variables	Mean squares				CV%
	Combinations (C)	Genotypes (G)	C × G	Block	
Chl *a*	13.05^{**}	14.78^{**}	4.32^{**}	0.42^{ns}	15.14
Chl *b*	0.74^{**}	2.57^{**}	0.37^{**}	0.01^{ns}	12.76
Chl *total*	20.17^{**}	22.35^{**}	6.14^{**}	1.85^{ns}	11.43
Car	1.96^{**}	1.08^{**}	0.44^{**}	0.05^{ns}	12.34
LDM	308.11^{**}	1027.97^{**}	152.45^{**}	6.44^{ns}	6.38
StDM	41.54^{**}	95.75^{**}	39.57^{**}	16.37^{*}	7.67
ShDM	521.96^{**}	1427.11^{**}	273.52^{**}	28.47^{*}	4.71
RDM	10.51^{**}	10.61^{**}	5.11^{**}	0.76^{ns}	7.15
LAR	7.74^{ns}	446.18^{*}	90.16^{ns}	92.36^{ns}	19.47
Fiber%	62.53^{**}	346.71^{**}	43.32^{**}	4.78^{ns}	6.03
SW	51.98^{**}	509.32^{**}	39.10^{**}	4.87^{ns}	8.01
BW	0.066^{**}	2.549^{**}	0.033^{*}	0.004^{ns}	9.27
DF	4	2	8	3	

ns, *, **, non-significant and significant at $p \leq 0.05$ and ≤ 0.01, respectively; CV = coefficient of variation; DF = degrees of freedom.

According to the interaction between the combinations of N:K fertilization and cotton genotypes (Figures 2A and 2B), 'BRS Rubi' obtained the highest content of chlorophyll *a* (10.61 mg g^{-1} FM) and chlorophyll *b* (2.79 mg g^{-1} FM) under the combinations of 100:100% and 50:125% N:K, respectively, with increments of 123.83 and 121.42% compared to the lowest contents of chlorophyll *a* (4.74 mg g^{-1} FM) and chlorophyll *b* (1.26 mg g^{-1} FM), obtained with the proportion of 125:50% N:K in 'BRS Safira'. These results indicate that higher proportions of potassium contributed to increasing chlorophyll pigment, since this nutrient stimulates the activity of the RuBisCO enzyme, the capture of light and its transformation into energy for the photosynthetic processes of the plant, in addition to improving the absorption of water by the plant by participating in the guard cells, in addition to being involved in nitrogen absorption and beginning of metabolization (LIMA, 2018).

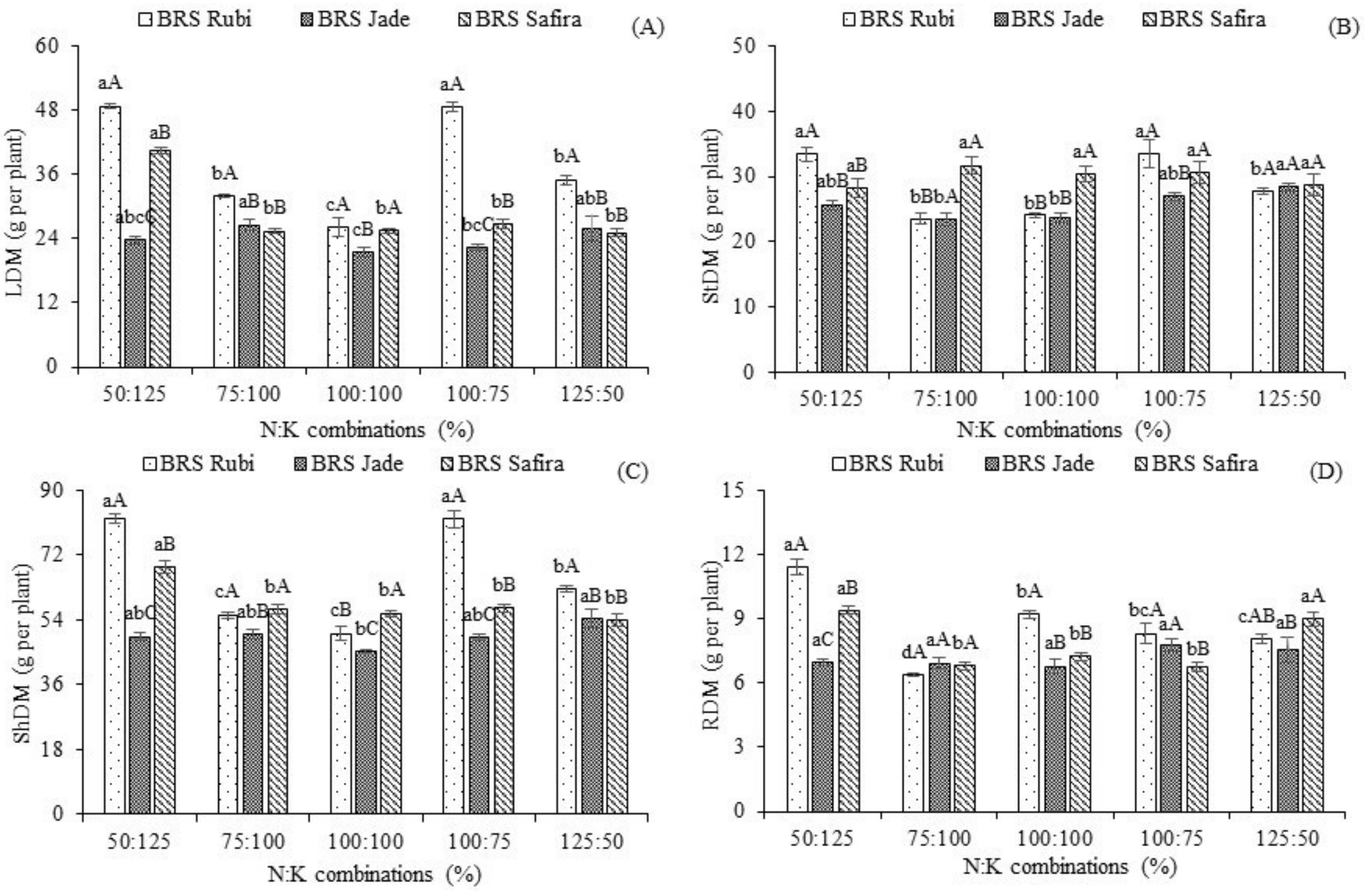


In each combination, bars with the same uppercase letter indicate that there is no significant difference between the means of the genotypes for the same fertilization combination and bars with the same lowercase letter indicate that the means between the N:K combinations do not differ from each other for the same genotype by Tukey test, $p \leq 0.05$. Vertical bars represent the standard error of the mean ($n = 4$).

Figure 2. Chlorophyll *a* – Chl *a* (A), Chlorophyll *b* – Chl *b* (B), Chlorophyll *total* – Chl *total* (C) and Carotenoids – Car (D) as a function of the interaction between combinations of N:K fertilization and colored cotton genotypes, at 85 days after sowing.

For the chlorophyll *total* (Chl *total*) and carotenoids (Car) contents, the combination of fertilization with 100:100% of the N:K recommendation promoted the highest contents, 13.02 and 3.60 $mg\,g^{-1}$ FM, respectively, for the genotype 'BRS Rubi' (Figures 2C and 2D). On the other hand, the increase in the proportion of nitrogen and decrease of potassium in the combination 125:50% N:K for 'BRS Safira' resulted in the lowest values (6.57 and 1.57 $mg\,g^{-1}$ FM), with reductions of 49.53 and 56.38% for total chlorophyll and carotenoids, respectively, when compared to plants of the same genotype that received fertilization with 100:100% N: K (Figures 2C and 2D). These results indicate that fertilization in an adequate proportion can promote a positive effect on pigment synthesis, with effects on the photosynthesis and production of colored cotton (LIMA et al., 2017).

In the decomposition of the interaction between different combinations of N:K fertilization and cotton genotypes for leaf dry mass (LDM), the combinations of 50:125 and 100:75% of N:K stood out among these interactions for the genotype 'BRS Rubi', leading to LDM of 48.71 and 48.62 g per plant, respectively. On the other hand, the lowest values for LDM were found when cotton plants received 100:100% of the N:K combination in the genotypes 'BRS Rubi' and 'BRS Jade', with 26.08 and 21.51 g per plant, respectively (Figure 3A). This result suggests a possible response of cotton to higher doses of K, favoring a greater efficiency in the absorption and utilization of nitrogen by the plant, since potassium has the function of activating the enzyme nitrate reductase (NR), responsible for the production of nitrite, which accumulates in the chloroplasts of the leaves, to later be reduced to ammonia, which is fixed via glutamate synthase in amino acids, such as glutamine and glutamate, potentially stimulating leaf production (SOARES et al., 2020).



In each combination, bars with the same uppercase letter indicate that there is no significant difference between the means of the genotypes for the same fertilization combination and bars with the same lowercase letter indicate that the means between the N:K combinations do not differ from each other for the same genotype by Tukey test, $p \leq 0.05$. Vertical bars represent the standard error of the mean ($n = 4$).

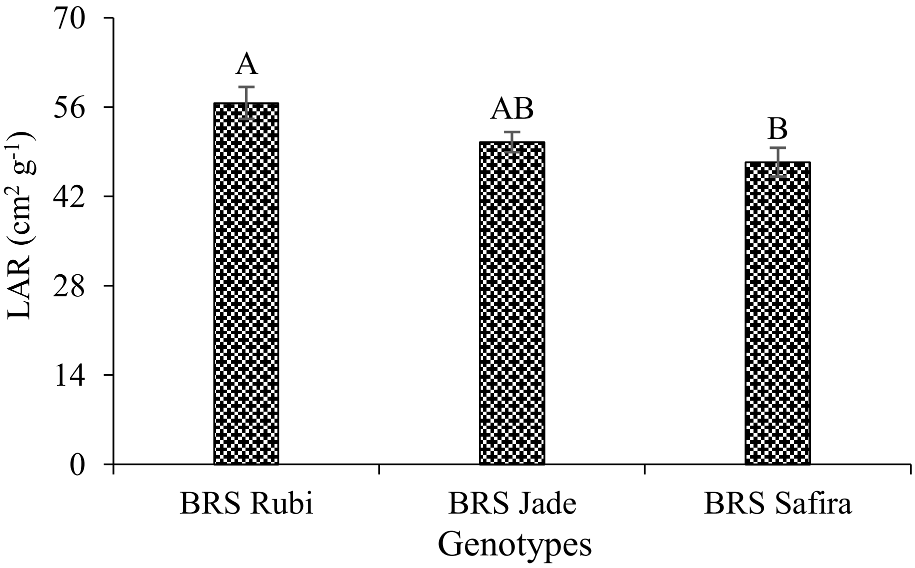
Figure 3. Dry mass of leaf - LDM (A), stem - StDM (B), shoot - ShDM (C), and root - RDM (D) as a function of the interaction between combinations of N:K fertilization and colored cotton genotypes, at 120 days after sowing.

Stem dry mass was higher for the genotype ‘BRS Rubi’, with means of 33.39 and 33.42 g per plant for fertilization with 50:125 and 100:75% N:K, with increments of 9.95 and 9.98 g per plant, respectively, compared to plants fertilized with 75:100% N:K, with StDM of 23.44 g per plant (Figure 3B). According to Tartaglia et al. (2020a), agronomic efficiency in nitrogen utilization tends to decrease with increasing N doses (0, 50, 100, 150, and 200 kg ha^{-1}), a finding that may vary between colored cotton genotypes, as ‘BRS Topázio’ proved to be the most responsive genotype to nitrogen fertilization, resulting in higher dry mass production when compared to ‘BRS Rubi’, ‘BRS Safira’, and ‘BRS Verde’. In addition, studies indicate that adequate potassium fertilization has the potential to promote an increase in the uptake and utilization of nitrogen and phosphorus by crops, improving the utilization rate of nitrogen fertilizers (REID et al., 2016).

An effect of the 50:125 and 100:75% N:K combinations was observed in LDM and StDM, as the highest values of shoot dry mass (ShDM) were obtained in the genotype ‘BRS Rubi’, 82.11 and 82.04 g per plant under these combinations, with increments in ShDM of 66.45 and 66.68% when compared to ‘BRS Jade’ and 19.60 and 43.00% when compared to ‘BRS Safira’, respectively (Figure 3C). The economical dose of 50% N had a similar effect to the dose of 100% N probably due to the gene expression of ‘BRS Rubi’, which can influence its nutritional requirements (TARTAGLIA et al., 2020b).

For root dry mass (RDM) as a function of the interaction between the combinations of N:K fertilization and cotton genotypes at 120 DAS, the genotypes ‘BRS Rubi’ and ‘BRS Safira’ stood out, with increments under the N:K combination of 50:125% for both ‘BRS Rubi’ (11.40 g per plant) and ‘BRS Safira’ (9.39 g per plant) (Figure 3D). These data indicate, in agreement with the other biomass values, that the increase in the potassium dose can contribute to a greater efficiency of the plant’s metabolism in relation to nitrogen, which also favors root growth (TAVARES; BELTRÃO, 2020).

Among the genotypes analyzed for leaf area ratio, 'BRS Rubi' obtained the highest value, 56.65 cm^2 g^{-1}, with increase of 19.61% when compared to the genotype 'BRS Safira', which had LAR of 47.36 cm^2 g^{-1} (Figure 4). Thus, it can be seen that 'BRS Rubi' had greater growth potential, increasing the leaf area per unit mass of the aerial part (LAR), which can contribute to increasing the capacity of the plant in the processes of CO_2 assimilation and photosynthesis (ZUCARELI et al., 2012).



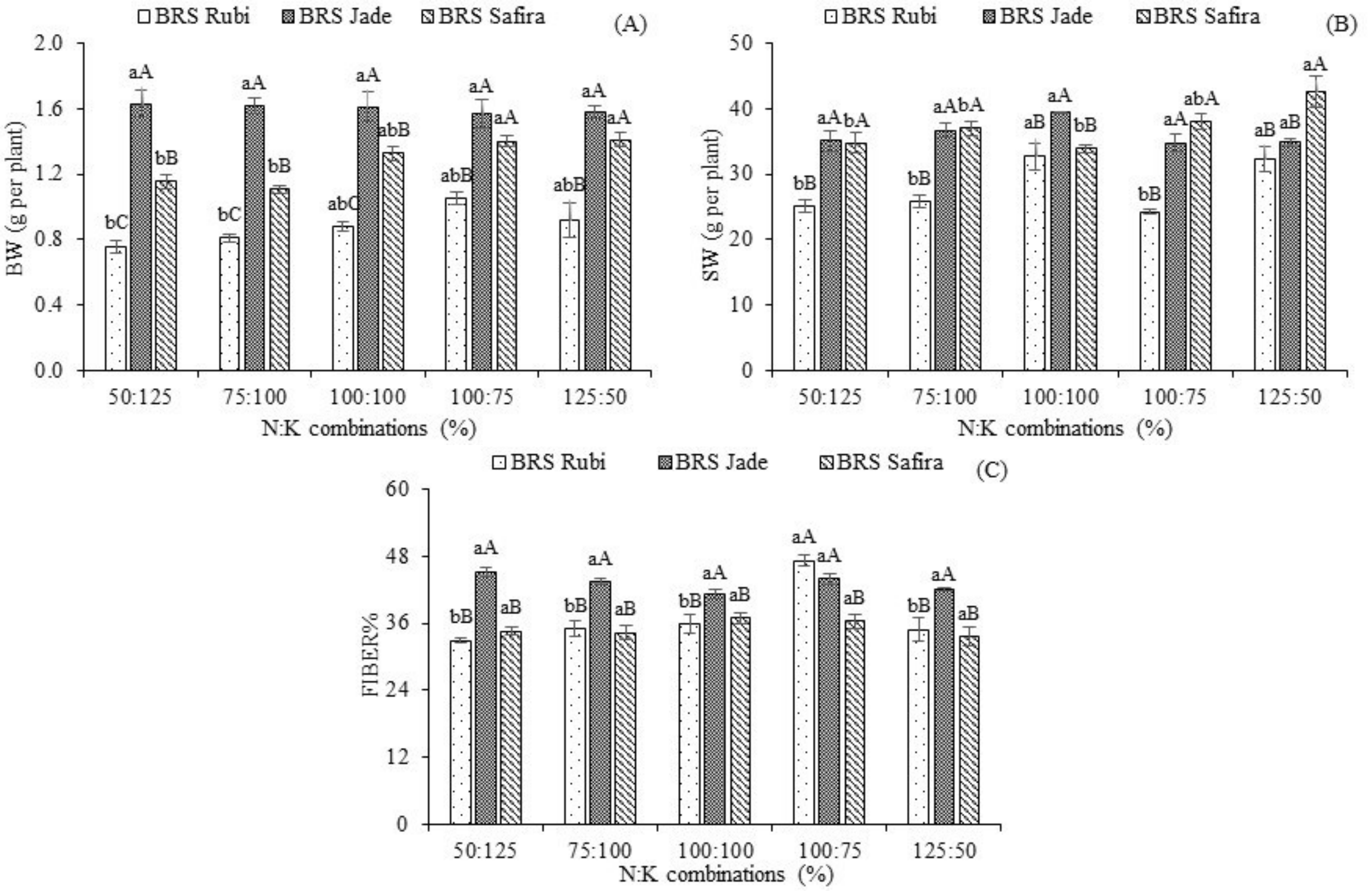
Bars with the same uppercase letter indicate that the means between the genotypes do not differ from each other by Tukey test, p ≤ 0.05. Vertical bars represent the standard error of the mean (n = 4).

Figure 4. Leaf area ratio - LAR of cotton genotypes at 120 days after sowing.

The genotype 'BRS Jade' had the highest average boll weight (BW) under all fertilization combinations, 1.59 g per plant, but did not differ from 'BRS Safira' under the combinations with 100:75 and 125:50% N:K (Figure 5A). Although 'BRS Rubi' stood out with the highest accumulation of pigments and biomass (Figures 2 and 3), it was inferior for BW, with decreases of 0.87, 0.80, 0.73, 0.51 and 0.66 g per plant under fertilization with 50:125%, 75:100%, 100:100%, 100:75% and 125:50%, respectively, when compared to 'BRS Jade' (Figure 5A). This suggests that 'BRS Rubi' directs more energy to the vegetative stage and less energy to flower production and boll formation, as indicated by LAR (Figure 4). According to Santos et al. (2016), the production of 'BRS Topázio' colored cotton increased as a function of nitrogen doses applied to the soil (0, 60, 80, 100 and 120 mg of N kg^{-1} of soil), reaching the highest production (327.2 g per plant) when associated with fertilization with 120 mg of N kg^{-1} of soil, at 130 DAS.

Fertilization with 50:125, 75:100, and 100:75% N:K negatively affected the seed production of 'BRS Rubi', with total seed weight (SW) of 25.45, 25.30, and 24.03 g per plant, respectively; on the other hand, the genotypes 'BRS Jade' and 'BRS Safira' stood out under these combinations, with means of 34.26 and 33.96 (50:125%), 36.34 and 37.32 (75:100%), and 35.23 and 37.51 g per plant (100:75%), respectively (Figure 5B). In general, 'BRS Rubi' showed lower SW and BW, because it comes from the cross between a material introduced from the USA, which had a fiber of dark brown color, with the cultivar CNPA 7H, which had white fiber of good quality and wide adaptation to the Northeast region, but with little genetic selection for characteristics of fiber quality and yield (EMBRAPA, 2011). These results corroborate those reported by Tartaglia (2018), who studied the agronomic performance of naturally colored cotton under nitrogen fertilization and stated that 'BRS Rubi' showed lower yield compared to other colored cotton genotypes, such as 'BRS Topázio'.

Regarding the fiber percentage (Fiber%), there was an increase of 29.84% in 'BRS Rubi' fertilized with the 100:75% N:K combination compared to 'BRS Safira', but it did not differ statistically from 'BRS Jade' under this combination. For the other combinations of fertilization, 'BRS Rubi' was inferior to 'BRS Jade', standing out with means of 45.20, 43.44, 41.21, and 42.01% when fertilized with 50:125, 75:100, 100:100, and 125:50%, respectively (Figure 5C). The fiber percentage of the genotypes varied as a function of the combination of N:K used in the nutritional management of the plants, since adequate doses of N are closely linked to the production of amino acids, photosynthetic rate, and biomass accumulation, with effects on the physiological quality and chemical composition of the fibers (ALVES et al., 2021).



In each combination, bars with the same uppercase letter indicate that there is no significant difference between the means of the genotypes for the same fertilization combination and bars with the same lowercase letter indicate that the means between the N:K combinations do not differ from each other for the same genotype by Tukey test, $p \leq 0.05$. Vertical bars represent the standard error of the mean (n = 4).

Figure 5. Mean boll weight – BW (A), total seed weight – SW (B), and fiber percentage - Fiber% (C) as a function of the interaction between cotton genotypes and N:K fertilization combinations, at 120 days after sowing.

CONCLUSIONS

The interaction between the genotype 'BRS Rubi' with the combination of 100:75% N:K of the recommendation of fertilization promoted the highest dry mass accumulation and fiber percentage. For the production of bolls with higher weight, the genotype 'BRS Jade' stood out in comparison to the others, regardless of the fertilization combination. On the other hand, the genotype 'BRS Safira' produced higher seed weight with the combination of 125:50% N:K fertilizer recommendation.

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