

Economic viability of colored cotton cultivars under potassium fertilization

Viabilidade econômica de cultivares de algodão colorido sob adubação potássica

Gisele L. dos Santos^{1*} , Valéria F. de O. Sousa² , Flávio P. da M. Silveira³ , Ênio G. F. Souza⁴ , João P. de O. Santos⁵ ,
João E. da S. Ribeiro¹ , Lindomar M. da Silveira¹ , Aurélio P. Barros Júnior¹ 

¹Department of Agronomic and Forestry Sciences, Universidade Federal Rural do Semi-Árido, Mossoró, RN, Brazil. ²Center of Science and Agrifood Technology, Universidade Federal de Campina Grande, Pombal, PB, Brazil. ³Universidade Federal do Rio Grande do Norte, Macaíba, RN, Brazil. ⁴Instituto Federal de Alagoas, Piranhas, AL, Brazil. ⁵Instituto Federal de Mato Grosso, Cuiabá, MT, Brazil.

ABSTRACT - For the expansion and economic viability of colored cotton production, it is essential to understand the potential costs associated with increased fertilization. Therefore, this study aimed to evaluate the economic viability of colored cotton cultivars under different potassium doses. Two experiments were conducted at the Rafael Fernandes Experimental Farm in Mossoró, RN, Brazil, during the 2019 and 2021 growing seasons. The experimental design was a randomized block design with split plots and four replications. Potassium doses (0, 60, 120, 180, and 240 kg ha⁻¹ of K₂O) were allocated to the main plots, while colored cotton cultivars (BRS Rubi, BRS Safira, BRS Verde, and BRS Topázio) were assigned to the subplots. Production costs (PC), gross revenue (GR), net revenue (NR), rate of return (RR), and profitability index (PI) were evaluated. Labor and potassium fertilizer accounted for the largest share of production costs. In the second growing season, the dose of 240 kg ha⁻¹ of K₂O provided the highest economic return for all cultivars. The cultivar BRS Topázio showed economic viability regardless of the potassium dose applied, while BRS Rubi had the lowest net revenue in both seasons. The cultivar BRS Verde achieved the highest profitability index at potassium doses of 87 and 240 kg ha⁻¹ of K₂O, indicating its potential for economically efficient production under adequate potassium fertilization.

RESUMO - Para a expansão e viabilidade econômica da produção de algodão colorido, é essencial compreender os possíveis custos associados ao aumento da adubação. Nesse sentido, este estudo teve como objetivo avaliar a viabilidade econômica de cultivares de algodão colorido sob diferentes doses de potássio. Dois experimentos foram conduzidos na Fazenda Experimental Rafael Fernandes, em Mossoró, RN, Brasil, nas safras de 2019 e 2021. O delineamento experimental foi em blocos casualizados, em esquema de parcelas subdivididas, com quatro repetições. As doses de potássio (0, 60, 120, 180 e 240 kg ha⁻¹ de K₂O) foram alocadas nas parcelas principais, enquanto as cultivares de algodão colorido (BRS Rubi, BRS Safira, BRS Verde e BRS Topázio) foram dispostas nas subparcelas. Foram avaliados os custos de produção (PC), a renda bruta (GR), a renda líquida (NR), a taxa de retorno (RR) e o índice de lucratividade (PI). A mão de obra e o fertilizante potássico representaram a maior parcela dos custos de produção. Na segunda safra, a dose de 240 kg ha⁻¹ de K₂O proporcionou o maior retorno econômico para todas as cultivares. A cultivar BRS Topázio apresentou viabilidade econômica independentemente da dose de potássio aplicada, enquanto a BRS Rubi apresentou a menor renda líquida em ambas as safras. A cultivar BRS Verde alcançou o maior índice de lucratividade nas doses de 87 e 240 kg ha⁻¹ de K₂O, indicando seu potencial para produção economicamente eficiente sob adequada adubação potássica.

Keywords: *Gossypium hirsutum*. Potassium chloride. Profitability. Economy.

Palavras-chave: *Gossypium hirsutum*. Cloreto de potássio. Rentabilidade. Economia.

Conflict of interest: The authors declare no conflict of interest related to the publication of this manuscript.



This work is licensed under a Creative Commons Attribution-CC-BY <https://creativecommons.org/licenses/by/4.0/>

Received for publication in: November 17, 2025.
Accepted in: March 30, 2026.

Editor in Chief: Aurélio Paes Barros Júnior
Section Editor: Bráulio Luciano Alves Rezende

Data Availability: The data that support the findings of this study can be made available, upon reasonable request, from the corresponding author.

***Corresponding author:**
<gisele1612@gmail.com>

INTRODUCTION

Brazil occupies a prominent place in cotton productivity, with the Northeast region being the second largest producer of the fiber, predominantly represented by the states of Bahia, Piauí, and Maranhão (ABRAPA, 2026). However, for the state of Rio Grande do Norte, production is still considered low, which may be related to the production system adopted, characterized by the low use of technologies (TARTAGLIA et al., 2020a).

In this scenario, there is a growing demand for fiber from the textile industry, driven by the production of articles aimed at supplying both national and international markets (SANTOS et al., 2024). Along with this expansion, interest in naturally colored cotton fiber has also increased due to its higher added value and environmental relevance, since it eliminates the need for artificial dyeing (RIBEIRO et al., 2024). However, as it is a natural fiber, it may show considerable variation in physical characteristics among cultivars, which can influence productivity and, consequently, economic viability (SANTOS et al., 2024). Therefore, the search for strategies that enhance the cultivation system of colored cotton becomes increasingly necessary.

In this context, colored cotton cultivars have been developed by the Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA), notably BRS Rubi,

BRS Safira, BRS Verde and BRS Topázio. These cultivars have agronomic and technological characteristics that, combined with higher added value compared to conventional white cotton, make the cultivation of naturally colored cotton a promising alternative for producers and the textile industry (SILVA et al., 2024). Thus, research involving different cultivars becomes fundamental, as it enables the identification of more productive and economically viable materials, better adapted to local conditions and with superior fiber quality, consequently contributing to the expansion of this production chain.

Furthermore, mineral nutrients are essential for plant growth and development, with nitrogen, phosphorus, and potassium being required in larger quantities by plants (SANTOS et al., 2022). Among these, potassium plays a key role in regulating enzymatic activity, cellular metabolism, photosynthesis, water use efficiency and, consequently, plant growth and production (GOES et al., 2023). According to Zhao et al. (2020) and Hussain, Ali and Gardezi (2021), potassium (K) stands out as the second most absorbed and exported nutrient by the cotton plant, and studies have shown that potassium fertilization can increase fiber productivity. However, Capitulino et al. (2017) studied the physiological aspects and growth of the colored cotton plant, cultivated with potassium fertilization, and concluded that it did not influence the plant phytomass and photosynthetic parameters.

Given these contrasting results, it is important that, before decision-making, the cost-effectiveness of potassium fertilization management in colored cotton cultivation be evaluated. This consideration becomes even more relevant due to the growing concern related to fertilizer dependence. Currently, national production is insufficient to meet market demand, with more than 80% of the fertilizers used in Brazil

being of foreign origin, which increases prices and limits access to this input (VIDAL et al., 2022).

Therefore, knowledge of production costs and their economic indicators allows producers to ensure greater economic return (SUJAN et al., 2024). In this context, the economic analysis of the crop, considering production costs associated with inputs, fertilization management, and operational practices, becomes essential for decision-making in the production system. In addition, determining the most economically viable fertilizer dose enables the efficient use of inputs and promotes the rational use of chemical fertilizers. Thus, this study aimed to evaluate the economic viability of colored cotton cultivars under potassium fertilization, based on the analysis of production costs and economic indicators related to crop profitability.

MATERIAL AND METHODS

The experiments were carried out in the second half of 2019 (1st season) and 2021 (2nd season), at the Rafael Fernandes Experimental Farm (latitude 5° 03' 31.00" S, longitude 37° 23' 47.57" W and 80 m altitude), located in the district of Alagoinha, rural area of the municipality of Mossoró, Rio Grande do Norte, Brazil. The climate of the region is characterized as BSh type, hot semi-arid tropical, with an average temperature of 27.40 °C and irregular annual rainfall, with an average of 673.90 mm (ALVARES et al., 2013).

The meteorological data, during the period of the experiments, were obtained from the Automatic Meteorological Station installed in the experimental Farm and are shown in Figure 1.

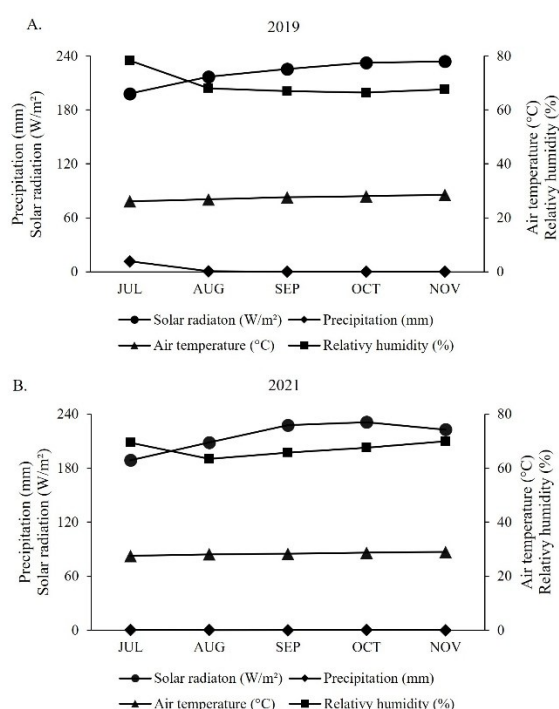


Figure 1. Mean values of meteorological data during the two colored cotton seasons (2019 and 2021).

The mean values for temperature, relative humidity, solar radiation, and precipitation were 27.41 and 28.32 °C, 69.43 and 67.23%, 221.00 and 215.76 W m⁻², and 2.44 and 0.20 mm for the years 2019 and 2021, respectively (Figure 1). The soil in the area was classified as *Argissolo Vermelho*

Distrófico Típico (Ultisol). Chemical and granulometric characterization was carried out using samples collected at a depth of 0.00 – 0.20 m (TEIXEIRA et al., 2017), with this information expressed in Table 1.

Table 1. Particle size and chemical analysis of the soil, referring to the experimental areas, at depths of 0.00 – 0.20 m, for two seasons, 2019 and 2021.

Depth	Sand	Silt	Clay	pH	P*	K ⁺	Na ⁺	Ca ²⁺	Mg ²⁺	Al ³⁺
m	-----kg kg ⁻¹ -----			mg dm ⁻³		-----cmol _c dm ⁻³ -----				
2019										
0.00 – 0.20	0.90	0.03	0.07	7.50	8.00	0.10	0.04	1.30	0.20	0.00
2021										
0.00 – 0.20	0.90	0.03	0.07	5.60	4.20	0.11	0.01	0.78	0.30	0.00

*Extractor: Mehlich⁻¹.

The treatments consisted of five doses of potassium (0, 60, 120, 180, 240 kg ha⁻¹ of K₂O in the form of potassium chloride - 61% of K₂O) and four cultivars of colored cotton (BRS Rubi, BRS Safira, BRS Topázio and BRS Verde). The experimental design used was randomized blocks, with four replications and in a split-plot scheme, with potassium doses being allocated to the plots and cotton cultivars to the subplots.

The materials BRS Rubi, BRS Safira, BRS Topázio and BRS Verde were obtained directly from EMBRAPA and multiplied to obtain seeds and carry out the experiments.

The preparation of the area was carried out in a

conventional way, with plowing and harrowing. The irrigation system used was a drip irrigation system, with emitters spaced 0.20 m apart and with a flow rate of 1.60 L h⁻¹, with the average daily depth determined based on the crop coefficient (K_c) (ALLEN et al., 1998). The initial, mid-season, and final reference K_cs were 0.35, 1.10 and 0.39 in the 1st season, and 0.36, 1.15 and 0.45 in the 2nd season. Thus, the gross depths corresponded to 685 and 662 mm in the first and second season, respectively. Irrigation was suspended at 115 and 110 days after sowing for the first and second harvests, respectively. The chemical analysis of irrigation water is described in Table 2:

Table 2. Chemical analysis of the water used for irrigation during the 2019 and 2021 seasons.

pH	EC	K ⁺	Na ⁺	Ca ²⁺	Mg ²⁺	Cl ⁻	CO ₃ ²⁻	HCO ₃ ⁻	SAR	Hardness
-----H ₂ O----		----- dS m ⁻¹ -----		-----mmol _c L ⁻¹ -----						mg L ⁻¹
2019										
7.90	0.91	0.63	2.20	3.20	2.60	3.60	1.00	6.10	1.30	290
2021										
7.40	0.56	0.56	1.47	3.10	1.90	1.80	0.50	2.90	0.90	250

*EC = electrical conductivity of water; SAR= sodium adsorption ratio.

The experimental area corresponded to 851.2 m², and each experimental subplot consisted of four rows with 19 plants each, occupying a total area of 10.64 m² (3.8 m × 2.8 m), considering the spacing of 0.20 m between plants and 0.70 m between rows. As the net plot area, only the two central rows were considered, disregarding the plants at each end.

Sowing was carried out manually, by placing three seeds per hole, at a depth of 0.05 m. The sowing dates were July 9, 2019, and July 28, 2021. Thinning was performed when the plants had three definitive leaves, leaving only one plant per hole. In both seasons, phytosanitary control was carried out using three manual weeding operations, and chemical control of pests (aphids, mites, and thrips) with

commercial products based on Imidacloprid and Beta-Cyfluthrin, Spiromesifen and Thiamethoxam, as recommended in the leaflet for the crop.

The first harvest was carried out at 106 days after sowing (DAS) in the first season and at 102 DAS in the second season, manually, corresponding to the harvest of the bolls of the lower third of the plant, and the others were carried out weekly, according to the opening of the other bolls. Crop cycle corresponded to 133 days in the first season and 123 days in the second season. Seed cotton productivity was determined by weighing the material harvested in the net plot area on a digital scale and then extrapolating the value to kg ha⁻¹ (Table 3).

Table 3. Average seed cotton productivity of colored cultivars fertilized with potassium rates, in two seasons, 2019 and 2021.

Average seed cotton productivity (kg ha ⁻¹)			
K doses (kg ha ⁻¹)	Cultivares	2019	2021
0	BRS Rubi	2,139.77	1,357.55
	BRS Safira	2,172.38	1,677.12
	BRS Topázio	3,319.08	2,105.19
	BRS Verde	2,103.13	1,568.26
60	BRS Rubi	2,285.30	1,593.10
	BRS Safira	2,199.01	1,817.30
	BRS Topázio	3,237.21	2,238.84
	BRS Verde	2,751.80	1,681.65
120	BRS Rubi	2,231.97	1,690.52
	BRS Safira	2,208.98	2,120.63
	BRS Topázio	2,866.98	2,317.91
	BRS Verde	2,541.03	1,835.21
180	BRS Rubi	2,131.78	1,884.08
	BRS Safira	2,346.36	2,394.02
	BRS Topázio	2,655.47	2,782.12
	BRS Verde	2,327.40	2,115.69
240	BRS Rubi	1,960.53	2,093.65
	BRS Safira	2,417.89	2,478.02
	BRS Topázio	2,608.20	3,060.79
	BRS Verde	2,099.37	2,302.35

Economic indicators were evaluated to estimate the production costs (PC) of one hectare of seed cotton at the end of each cultivation based on the methodology proposed by Souza et al. (2020) and cost with fees proposed by Conab (2010). To determine expenses, variable costs (labor, fertilizers, pesticides and others), administrative expenses, technical assistance, rural territorial tax, financial expenses, as well as fixed costs (depreciation and periodic maintenance of improvements/facilities) and remuneration were analyzed.

Administrative and technical assistance expenses corresponding to 3 and 2% of the total cost of the crop were adopted. The fixed value of R\$ 10.00 was considered as the minimum rural territorial tax (RTT) to be paid in an agricultural year, using (Equation 1):

$$RTT (R\$ ha^{-1}) = RTT \text{ value } (R\$) \times \left(\frac{\text{Crop cycle (days)}}{365 \text{ days}} \right) \quad (1)$$

Interest on the financing was attributed to the resources needed to fund the crop, with the rate (7.49% per year) corresponding to the time of release or use of the capital, calculated according to Equation 2:

$$\text{Interest } (R\$ ha^{-1}) = \text{costing amount } (R\$ ha^{-1}) \times \left(\frac{\text{Crop cycle (days)}}{365 \text{ days}} \right) \times 7.49\% \quad (2)$$

To calculate the depreciation of improvements/

installations of the irrigation system for one hectare of colored cotton, the use of 14,285.71 meters of low-density polyethylene dripping tape was considered, with spacing between emitters of 0.20 m and a nominal diameter of 16 mm (value of the new good = R\$ 0.27 m⁻¹) with a useful life of two years, in addition to PVC pipes and connections (value of the new item = R\$ 1,423.25) and a 3.0 hp motor pump set (value of the new item = R\$ 1,100.00) with a durability of sixteen years. Depreciation was calculated using Equation 3:

$$\text{Depreciation } (R\$ ha^{-1}) = \left(\frac{\text{value of the new good } (R\$ ha^{-1})}{\text{useful life of the good (days)}} \right) \times \text{Crop cycle (days)} \quad (3)$$

For periodic maintenance of the installations and the irrigation system, a maintenance fee of 1% was adopted, using Equation 4:

$$\text{Maintenance } (R\$ ha^{-1}) = \text{new property value } (R\$ ha^{-1}) \times \left(\frac{\text{Crop cycle (days)}}{365 \text{ days}} \right) \times 1\% \quad (4)$$

Considering that the producer's investment should be remunerated, as if the capital were invested in any other alternative investment, the remuneration was calculated by adopting a rate of return of 6% per year, through Equation 5:

$$\text{Remuneration } (R\$ ha^{-1}) = \text{new property value } (R\$ ha^{-1}) \times \left(\frac{\text{Crop cycle (days)}}{365 \text{ days}} \right) \times 6\% \quad (5)$$

With these data at hand, gross revenue (GR), net revenue (NR), rate of return (RR) and profitability index (PI) were evaluated. The rates and prices used in this study were established based on information obtained through local surveys and with Embrapa business sector.

GR was obtained by multiplying the seed cotton productivity (P) of each treatment by the value of the product (V) paid to the producer at a cost of R\$ 6.00 reais per kg ($GR = P \times V$). NR was calculated by subtracting the total production costs from inputs plus services (TC) from GR ($NR = GR - TC$). RR was obtained by the ratio of GR and the TC of each treatment ($RR = GR/TC$). PI, expressed as a percentage, was obtained by the ratio between NR and GR ($PI = (GR/NR) \times 100$).

The data were subjected to analysis of variance (ANOVA), and the seasons were initially evaluated separately. The homogeneity of residual variances between seasons was verified by the ratio between the largest and smallest residual mean squares (MSmax/MSmin), adopting the criterion according to which values lower than seven indicate homogeneity, allowing the joint analysis of the experiments. When significant differences were detected, the means of qualitative treatments were compared using the Tukey test at 5% probability level, while the data referring to quantitative factors were subjected to regression analysis. All statistical analyses were performed using the SISVAR program (FERREIRA, 2019). Graphs were created using Microsoft Excel version 2009.

RESULTS AND DISCUSSION

The total costs for growing one hectare of colored cotton considering the maximum dose of potassium were R\$ 5,890.68 ha⁻¹ in the first season and R\$ 5,788.90 ha⁻¹ in the second (Table 4). The variable costs that fell on these values were on average 66%, while the fixed costs were responsible for 13%. These results are comparable to those of Zahedi, Eshghizadeh and Mondani (2014), who studied the efficiency of energy use and economic analysis in the white cotton production system in an arid region of Iran and found that about 67% of the total cost came from of variable cost. Thus, inputs and labor are among the highest costs, with irrigation or fertigation, planting, harvesting, and weeding being the largest parts of the total labor force for cotton production for the latter.

A higher total cost of cotton production was observed in the 2019 season (Table 4), with some influence from the longer crop cycle, during the first season, which may intensify higher expenses and favor higher administrative and financial expenses.

Among the variable cost indicators, the cost of labor was responsible for 66.15% of the total cost of farming, followed by fertilizers (14.26%), machine rental (6.23%), seeds (3.89%) and agricultural defensives (2.28%).

Labor, therefore, represents a considerable expense in cotton production costs. This is because there is a high demand for operations such as cultural practices, irrigation management, weeding and harvesting (WEI et al., 2020), especially in properties that do not use technological resources to operate these functions, which increases the

number of contractors and, consequently, labor costs.

The production cost also increased due to the use of potassium fertilizer for the two seasons studied. This is due to the price of fertilizer, so the higher the dose of fertilizer, the greater the amount paid for the acquisition of this input. However, according to Yang et al. (2016), using cheaper sources favors cost reduction, suggesting the use of KCl, which is considered a good source of K₂O, due to its lower cost and better yield compared to other sources, favoring its use. However, moderate use of this source of potassium is essential, in view of its high saline content, which can cause soil salinity.

The contribution of potassium fertilization to production costs was around 0, 3.39, 6.54, 9.48 and 12.22% for doses of 0, 60, 120, 180 and 240 kg ha⁻¹ of K₂O in the first season. In the second season, the costs corresponded to 0, 3.89, 7.46, 10.76 and 13.82% for the same doses, with an increase between the values, which is justified by the variation in the price of fertilizer over the seasons. Despite this variation being low between the seasons studied, the crisis in the acquisition of fertilizers, due to the post-pandemic period and the war in Ukraine, pointed out in 2022, may become something alarming for the increase in costs in the following seasons. Thus, it is important to adopt measures that propose a smaller participation in the use of fertilizers.

As for other costs, machinery services had a low impact, since their use was limited to soil preparation. However, this is reflected in higher labor costs, as mentioned earlier. Seeds, on the other hand, despite representing a smaller share of the variable costs, are responsible for a relatively high price, especially in the first year of cultivation, due to the considerable fluctuation in the acquisition price of this input.

In general, producers tend to use their own seeds, purchasing them mainly to start production, which contributes to lower costs. However, this practice is more common on small properties, and the expansion of the production chain requires greater adaptation of the sector to the growth of this fiber segment. Regarding the use of pesticides, their participation was relatively small between seasons, contributing to a lower share in production costs. Nevertheless, this factor depends on the occurrence of pests and diseases in crops, which may lead to significant changes in the cost structure related to pesticide use.

Given this, it is possible to state that the high cost of inputs in cotton production can limit profitability. As proposed by Pabuayon et al. (2021), the weight of inputs is the main alarming factor, especially among small farmers, as the purchase of materials is limited due to financial insolvencies. In addition, the factors that interfere in the formation of agricultural prices branch out into different sectors and can even go through uncontrollable conditions, such as edaphoclimatic conditions.

In this context, the highest yield per hectare will not always characterize greater profit, especially considering that it is possible to lower costs by using a smaller amount of inputs in the crop (ARAÚJO et al., 2013). Therefore, the use of efficient cultivars is recommended, that is, those that have high yields, lower demand for nutrients and that are more tolerant to pests and diseases, reducing possible increases in variable costs.

Table 4. Coefficients of variable and fixed costs in the production of one irrigated hectare of colored cotton cultivated with different doses of potassium, in two seasons, 2019 and 2021.

Discrimination	Unit	2019		2021	
		Qty	R\$	Qty	R\$
I - Operating expenses of the crop					
1 - Machine rental					
Tractor with hydraulic harrow, tractor with leveling blade	h	2.00	240.00	2.00	240.00
Limestone application	h	-	0.00	-	0.00
2 – Labor					
Installation of the irrigation system	daily rate	3.00	150.00	3.00	150.00
Digging of planting holes	daily rate	3.00	150.00	3.00	150.00
Manual sowing	daily rate	4.00	200.00	4.00	200.00
Thinning	daily rate	4.00	200.00	4.00	200.00
Irrigation or fertigation	h	108.00	540.00	104.00	520.00
Manual weeding (hoe)	daily rate	8.00	400.00	8.00	400.00
Spraying (insecticide)	h	24.00	120.00	24.00	120.00
Harvesting (manual)	daily rate	16.00	800.00	16.00	800.00
3 – Seeds					
Colored cotton	kg	25.00	200.00	25.00	150.00
4 – Fertilizers					
Micronutrient compound	kg	1.00	90.00	1.00	90.00
Urea (46% N) - 90 kg ha ⁻¹ de N	kg	161.43	290.57	161.43	290.57
Potassium chloride (61% K ₂ O) 240 kg ⁻¹ de K ₂ O	kg	400.00	720.00	400.00	800.00
Monoammonium phosphate (61% P ₂ O ₅ e 12% de N) - 80 kg ha ⁻¹ de P ₂ O ₅	kg	131.15	167.87	131.15	170.50
Other					
5 - Agricultural pesticide					
Insecticide (Actara®)	kg	0.10	20.00	0.10	20.00
Insecticide (Connect®)	L	0.75	82.50	1.00	0.00
Insecticide (Oberon®)	L	1.00	0.00	0.60	54.00
6 - Other expenses					
Electricity for irrigation	kWh	304.18	115.59	302.24	139.03
Soil and water analysis	Unit	1.00	60.00	1.00	30.00
Personal Protective Equipment	Unit	1.00	80.00	1.00	80.00
Subtotal (A)	R\$ ha ⁻¹	-	4,626.53	-	4,604.10
II - Other expenses					
7 - Administrative expenses (3% of crop costs)	R\$ ha ⁻¹	-	138.80	-	138.12
8 - Technical assistance (2% of crop costs)	R\$ ha ⁻¹	-	92.53	-	92.08
9 - Rural land tax (R\$ 10.00 per year)	R\$ ha ⁻¹	-	3.64	-	3.37
Subtotal (B)	R\$ ha ⁻¹	-	234.97	-	233.57
III - Financial expenses					
10 - Loan interest (7.49% per year)	R\$ ha ⁻¹	-	126.27	-	116.21
Subtotal (C)	R\$ ha ⁻¹	-	126.27	-	116.21
Variable cost (D) = (A+B+C)	R\$ ha ⁻¹	-	4,987.77	-	4,953.89
IV – Depreciations					
11 - Depreciation of improvements/facilities *	R\$ ha ⁻¹	-	740.16	-	684.51
Subtotal (E)			740.16	-	684.51
V - Other fixed costs					
12 - Periodic maintenance of improvements/facilities (1% per year)	R\$ ha ⁻¹	-	23.25	-	21.50
Subtotal (F)			23.25	-	21.50
Fixed cost (G) = (E+F)	R\$ ha ⁻¹	-	763.41	-	706.01
Operating cost (H) = (D+G)	R\$ ha ⁻¹	-	5,751.19	-	5,659.90
VI - Revenue from factors					
13 - Expected return on fixed capital (6% per year)	R\$ ha ⁻¹	-	139.49	-	129.01
Subtotal (I)	R\$ ha ⁻¹	-	139.49	-	129.01
Total cost (J) = (H+I)					
Dose of 240 kg ha ⁻¹ of K ₂ O	R\$ ha ⁻¹	-	5,890.68	-	5,788.90
Dose of 180 kg ha ⁻¹ of K ₂ O	R\$ ha ⁻¹	-	5,696.77	-	5,573.86
Dose of 120 kg ha ⁻¹ of K ₂ O	R\$ ha ⁻¹	-	5,502.85	-	5,358.81
Dose of 60 kg ha ⁻¹ of K ₂ O	R\$ ha ⁻¹	-	5,308.94	-	5,143.76
Dose of 0 kg ha ⁻¹ of K ₂ O	R\$ ha ⁻¹	-	5,115.03	-	4,928.71

*The average price paid per kg of KCl was R\$ 1.80 in the first season and R\$ 2.00 in the second season; the cost analysis preceded the acquisition crisis of this input, which has led to price increases.

When statistically analyzing the economic indices to produce seed cotton, for all economic variables, a joint analysis was performed, which showed a triple interaction ($p < 0.01$) between treatments.

The highest gross revenue was observed in the BRS Topázio cultivar, obtaining R\$ 20,029.00 ha^{-1} in the absence of potassium fertilization, in the first season (Figure 2A). For the cultivar BRS Verde, the maximum value of R\$ 15,714.38 ha^{-1} was obtained with the dose of 110 kg ha^{-1} of K_2O , followed by the cultivars BRS Safira and BRS Rubi, which

reached R\$ 14,380.06 ha^{-1} and R\$ 13,562.90 ha^{-1} using 240 and 88 kg ha^{-1} of K_2O . In the second season (Figure 2B), the highest revenues were R\$ 17,950.80 ha^{-1} (BRS Topázio), R\$ 15,198.70 ha^{-1} (BRS Safira), R\$ 13,686.38 ha^{-1} (BRS Verde) and R\$ 12,458.58 ha^{-1} (BRS Rubi), with a dose of 240 kg ha^{-1} of K_2O . The values obtained in the second season were lower than those obtained in the first, except for the cultivar BRS Safira, which obtained a 5% increase in the second season. This is justified by the lower production obtained by the cultivars in the second season (Table 3).

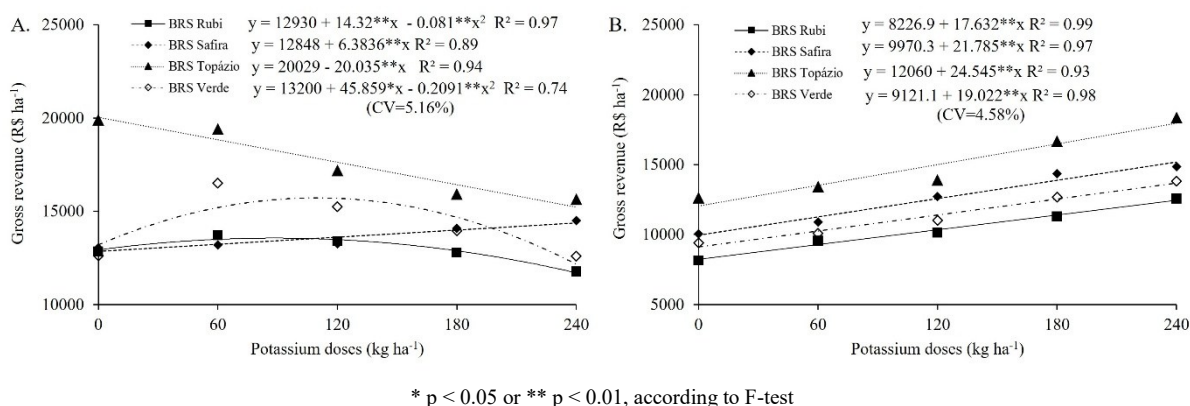


Figure 2. Gross revenue (R\$ per hectare) in colored cotton cultivars under potassium doses in two seasons, 2019 (A) and 2021 (B).

According to Conab (2010), gross or net revenue may change at each harvest, as observed in this study, as the planting variables obey different situations that must be periodically observed to improve the process of calculating these parameters. In addition to the influence of the predominant production system, and in the case of intensive use of technology, this can be considered the main reason for the increase.

In the first season (Figure 3A), the highest net revenues observed were R\$ 14,913.00 ha^{-1} (BRS Topázio), R\$ 10,257.78 ha^{-1} (BRS Verde) and R\$ 8,194.84 ha^{-1} (BRS

Rubi), with doses of 0, 101 and 66 kg ha^{-1} of K_2O . The BRS Safira cultivar was not described by any mathematical regression model, with an average net revenue of R\$ 8,110.68 ha^{-1} for K doses. In the second season (Figure 3B), the highest revenues observed with the cultivars were: R\$ 12,742.29 ha^{-1} (BRS Topázio), R\$ 9,409.84 ha^{-1} (BRS Safira), R\$ 7,897.52 ha^{-1} (BRS Verde) and R\$ 6,669.72 ha^{-1} (BRS Rubi), with a dose of 240 kg ha^{-1} of K_2O . Considering the differences between cultivars, it is noticeable that the BRS Rubi cultivar was one of the cultivars that showed the lowest net revenue in both seasons.

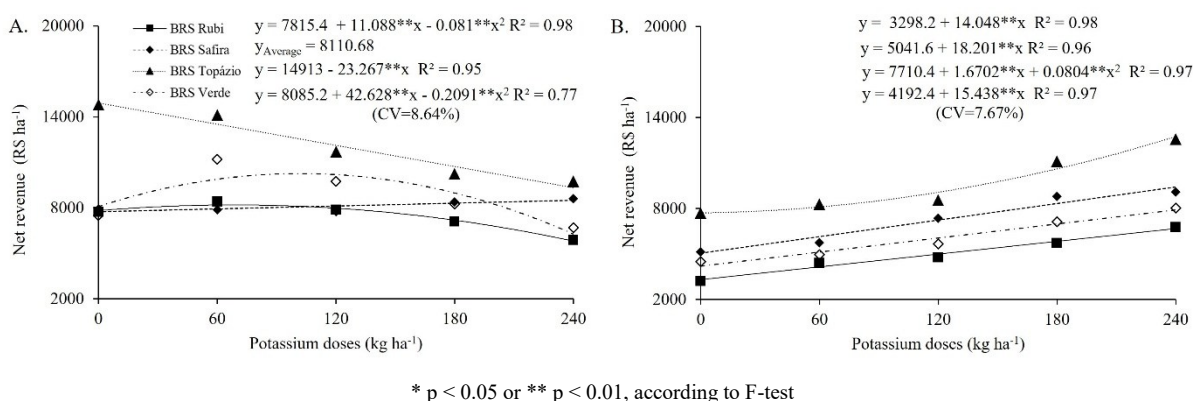


Figure 3. Net revenue (R\$ per hectare) in colored cotton cultivars under potassium doses in two seasons, 2019 (A) and 2021 (B).

It was observed that, in the second season, the maximum dose of potassium fertilizer favored a better net revenue for all studied cultivars, different from what was observed in the first season. This result characterizes that,

depending on the harvest, the yield of cultivars in relation to potassium fertilization may vary, as observed for BRS Topázio, although with lower yield. This may be related to the dynamics of potassium in the soil-plant system, which

undergoes oscillations due to edaphoclimatic conditions in each growing season, consequently affecting crop productivity and results in economic losses.

Thus, the behavior of net revenue was somewhat favorable, as the parameter was found to be positive, indicating that the activity is stable, that is, it has the possibility of expansion. As for the cultivars, although BRS Topázio is more prominent, this does not negate the importance of the production of the other cultivars evaluated in the research, considering that color variations between fibers are potentially attractive and promote appreciation during marketing.

The highest values for rate of return found in the 2019 season were obtained with BRS Topázio ($3.89 - 0 \text{ kg ha}^{-1}$ of K_2O), BRS Verde ($2.87 - 85 \text{ kg ha}^{-1}$ of K_2O) and BRS Rubi ($2.55 - 50 \text{ kg ha}^{-1}$ of K_2O) (Figure 4A). For the BRS Safira cultivar, no regression model was fitted, with an average value of 2.48 obtained between K doses. In the 2021 season (Figure 4B), the cultivar BRS Topázio obtained the highest rate (3.11) with the dose of 240 kg ha^{-1} of K_2O , followed by the cultivars BRS Safira (2.63), BRS Verde (2.37) and BRS Rubi (2.16) using the same dose. By comparing the seasons, it is possible to verify a higher rate of return in the first season, due to the higher yields (Table 3).

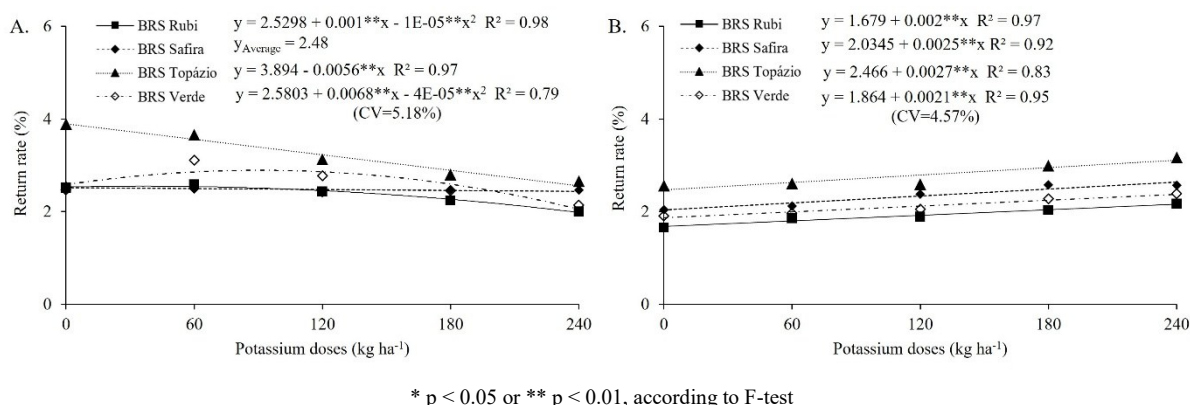


Figure 4. Rate of return (%) in colored cotton cultivars under potassium doses in two seasons, 2019 (A) and 2021 (B).

The rate of return and the profitability index consist of the ratio of production costs, gross revenue and net revenue, so they are indicators that best express the economic value of a system and assist in decision-making regarding the need to invest. In addition, it makes it possible to identify the occurrence of economic return, considering that the usefulness and success of any technique depend on the economic viability and costs involved (SUJAN et al., 2024).

The cotton crop has direct links with several processing industries, whether textile, oilseeds, or the livestock subsector. That is, its cultivation has a direct connection with the industrial sector. Thus, it is believed that, if there is an indication of a rate of return, it is worthwhile to invest in the cultivation system, since it is an important industrial input. A production with poor performance is due to different constraints. These constraints can be lack of technology, agricultural inputs and government support, or unfavorable weather conditions, pest interference, labor shortages, lack of credit, price inefficiencies, financial constraints, and rising production costs (ZELEKE et al., 2019). This means that economic viability varies from case to case and may or may not be directly related to productivity.

In this context, the future growth of colored cotton productivity will possibly be determined by the adoption of new technologies, including mechanization and correct use of inputs. Fishlow and Vieira Filho (2020) affirm the importance of research and technology in the expansion of cultivation in different seasons.

As for the profitability index, it was observed that in

the 2019 season (Figure 5A), the best value was obtained by the cultivar BRS Topázio (74.71%) in the absence of potassium, followed by BRS Verde (65.31%) and BRS Rubi (60.84%) with doses of 87 and 42 kg ha⁻¹ of K_2O . Cultivar BRS Safira was not described by the regression, showing an average value of 59.46%. For the 2021 season (Figure 5B), the maximum values were 67.81% (BRS Topázio), 62.45% (BRS Safira), 58.03% (BRS Verde) and 54.10% (BRS Rubi) with the use of the maximum dose of 240 kg ha^{-1} of K_2O .

It is possible to indicate that the cultivar BRS Topázio could require less input of fertilizers and generate greater economic benefits. A study to determine the economic dose of nitrogen to produce naturally colored cotton in the semi-arid region reported that a higher yield was achieved with the BRS Topázio cultivar (TARTAGLIA et al., 2020b), as seen in this study. However, the same authors also stated that a lower return was found with the BRS Verde cultivar, different from what was observed in our study, and it is possible to obtain greater profitability with this cultivar due to potassium fertilization.

Still according to the results, it was observed that for all cultivars, in both seasons, the profitability index was above 50%, pointing to the economic potential of colored cotton for producers. Thus, it is believed that it is essential to economically study the applications of local agricultural techniques, emphasizing the importance of adopting correct potassium fertilization, bearing in mind that the naturally colored cotton crop will respond to the use of this fertilizer if it meets the nutritional requirements.

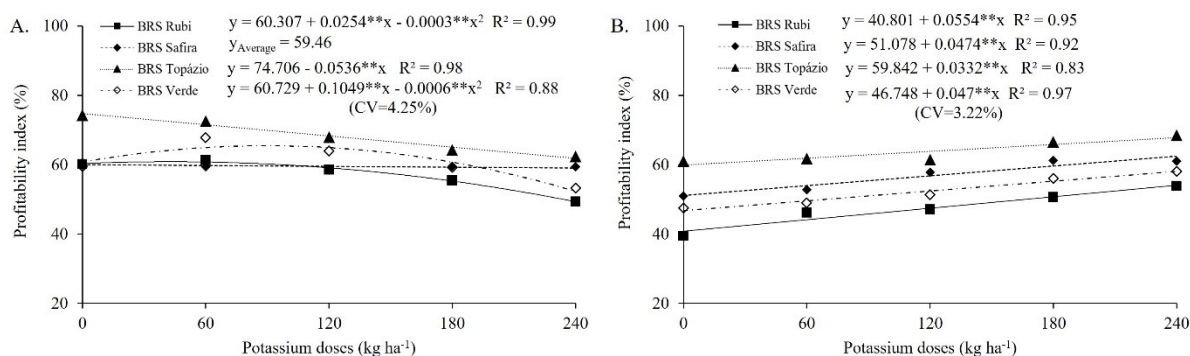


Figure 5. Profitability index (%) in colored cotton cultivars under potassium doses in two seasons, 2019 (A) and 2021 (B).

The increase in productivity observed with higher fertilizer doses indicates potential for improving crop performance. For producers, this result may represent an alternative to optimize nutrient management and maximize yield. However, the feasibility of this strategy depends directly on the cost of inputs, particularly considering the recent volatility in fertilizer prices in the agricultural market. According to Belay, Yami and Bekele (2020), who analyzed production costs and profitability of irrigated cotton in family farming systems in the Amibara district, Ethiopia, economic returns were more sensitive to fluctuations in price and yield than to total variable costs. In this context, efforts to enhance productivity should be accompanied by strategies that ensure a more stable and affordable supply of agricultural inputs, such as strengthening cooperatives involved in the commercialization of inputs and agricultural products.

CONCLUSIONS

Cultivar BRS Topázio is economically viable for use in the region, regardless of the potassium dose used. The BRS Rubi cultivar had the lowest net revenue in both seasons. Cultivar BRS Verde provided a higher profitability index when cultivated with doses of 87 and 240 kg ha⁻¹ of K₂O.

ACKNOWLEDGMENTS

We to thank for their financial support from the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES).

REFERENCES

ABRAPA – Associação Brasileira dos Produtores de Algodão. **Algodão no Brasil**. Available at: <<https://app.powerbi.com/view?r=eyJrIjoieYzkwZmU4ZjAtNWZlNi00YTJkLTNmOWMtNmJmZmMxNmFIZTZmliwidCI6IjRhMDk1OGIzLTg4MWQtNDBmYS05NTU1LTlwODQ1MzdYVWZkMyJ9>>. Access on: Mar. 30, 2026.

ALLEN, R. G et al. **Crop evapotranspiration: guidelines**

for computing crop water requirements. Rome: FAO, 1998. 300 p.

ALVARES, C. A. et al. Köppen's climate classification map for Brazil. **Meteorologische Zeitschrift**, 22: 711-728, 2013.

ARAÚJO, L. F. et al. Características fenológicas, agronômicas e tecnológicas da fibra em diferentes cultivares de algodoeiro herbáceo. **Revista Brasileira de Ciências Agrárias**, 8: 448-453, 2013.

BELAY, G.; YAMI, M.; BEKELE, A. Analysis of costs of production and profitability for irrigated cotton under smallholder production systems; the case of middle awash valley. **Ethiopian Journal of Agricultural Sciences**, 30: 1-16, 2020.

CAPITULINO, J. D. et al. Aspectos fisiológicos e crescimento do algodoeiro 'BRS topázio' cultivado com águas salinas e adubação potássica. **Revista Verde de Agroecologia e Desenvolvimento Sustentável**, 12: 267-272, 2017.

CONAB - Companhia Nacional de Abastecimento. **Custos de produção agrícola: a metodologia da CONAB**. Brasília, DF: CONAB, 2010. 60 p.

FERREIRA, D. F. SISVAR: A computer analysis system to fixed effects split plot type designs. **Revista Brasileira de Biometria**, 37: 529-535, 2019.

FISHLOW, A; VIEIRA FILHO, J. E. R. **Agriculture and industry in Brazil: innovation and competitiveness**. New York: Columbia Press, 2020. 244 p.

GOES, G.B. et al. Bioactivator, phosphorus and potassium fertilization and their effects on soil, physiology, production and quality of melon. **Acta Physiologia Plantarum**, 45: 56, 2023.

HUSSAIN, S.; ALI, H.; GARDEZI, S. T. R. Soil applied potassium improves productivity and fiber quality of cotton cultivars grown on potassium deficient soils. **Plos One**, 16: 0250713, 2021.

- PABUAYON, I. L. B. et al. Yield and Economic Response of Modern Cotton Cultivars to Nitrogen Fertilizer. **Agronomy**, 11: 2149, 2021.
- RIBEIRO, J. E. S. et al. Effect of nitrogen fertilization on the of colored cotton fibers in the Brazilian Semi-Arid region. **Journal of Natural Fibers**, 21: e2391010, 2024.
- SANTOS, G. L. et al. Agronomic components of colored cotton cultivars as a function of potassium doses in the semiarid region. **Revista Brasileira de Engenharia Agrícola e Ambiental**, 28: e275864, 2024.
- SANTOS, L. W. O. et al. Effect of nitrogen:potassium fertilization ratios and biostimulant application on broccoli plants. **Journal Soil Scienc Plant Nutrition**, 22: 4857-4867, 2022.
- SILVA, J. E. et al. Colored cotton crop wastes valorization through pyrolysis: a study of energetic characterization and analytical Py-GC/MS. **Scientific Reports**, 14: 9359, 2024.
- SOUZA, A. R. E. et al. Economic indicators of nitrogen fertilization in sunflower cultivars. **Bioscience Journal**, 36:1938–1950, 2020.
- SUJAN, M. H. K. et al. Economic viability of releasing Bt cotton in Bangladesh: An early insight. **Heliyon**, 10: e30589, 2024.
- TARTAGLIA, F. L. et al. Nitrogen utilization efficiency by naturally colored cotton cultivars in semi-arid region. **Revista Ciência Agronômica**, 51: 1-9, 2020a.
- TARTAGLIA, F. L. et al. Economical nitrogen dose for production of irrigated naturally colored cotton in the semi-arid region. **Revista Brasileira de Engenharia Agrícola e Ambiental**, 24: 783-789, 2020b.
- TEIXEIRA, P. C. et al. **Manual de métodos de análise de solo**. 3. ed. Brasília, DF: Embrapa, 2017. 573 p.
- VIDAL, E. C. F. et al. Marketing of nitrogenated fertilizers in Mato Grosso. **Journal of Interdisciplinary Debates**, 3: 30-66, 2022.
- WEI, W. et al. Estimating the economic viability of cotton growers in Punjab Province, Pakistan. **Sage Open**, 10: e21582440209, 2020.
- YANG, F. et al. Cotton yield and potassium use efficiency as affected by potassium fertilizer management with stalks returned to field. **Crop Science**, 56: 740-746, 2016.
- ZAHEDI, M.; ESHGHIZADEH, H. R.; MONDANI, F. Energy use efficiency and economical analysis in cotton production system in an arid region: A case study for Isfahan Province, Iran. **International Journal of Energy Economics and Policy**, 4: 43-52, 2014.
- ZELEKE, M. et al. Cotton production and marketing trend in Ethiopia: A review. **Cogent Food & Agriculture**, 5: 1-7, 2019.
- ZHAO, W. et al. Potassium (K) application alleviates the negative effect of drought on cotton fiber strength by sustaining higher sucrose content and carbohydrates conversion rate. **Plant Physiology and Biochemistry**, 157: 105-113, 2020.