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# The effects of nitrogen, phosphorus, and potassium levels on the yield and fiber quality of cotton cultivars

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**ABSTRACT**

The objective of this work was to evaluate the effects of nitrogen (N), phosphorus (P), and potassium (K) levels on the yield and fiber quality of cotton cultivars with different maturation cycles and chemical fertility gradients. The experimental design was a randomized block design with five replicates. The treatments consisted of a combination of 13 cotton cultivars (FM 910, FM 993, IMA 12427, IMA 1595, IMA 1600, IMA 2059, IMA 278, IMA 2968, IMA 3869, IMA 474, IMA 6035, IMA 690, and IMA 8276) at three levels of fertilization (50%, 100%, and 150% of the recommended dose of each nutrient) with nitrogen, phosphorus, and potassium. Cultivars IMA 2059, IMA 2968, and IMA 8276 had little or no response to increase fertility levels. However, they all produced more than 1000 kg $ha^{-1}$ of lint. Cultivars IMA 1600, IMA 3869, IMA 474, IMA 6035, and IMA 690 presented higher yields at the 150% level when compared to the 50% level, but these same yields were achieved with just the 100% recommended dose. IMA 6035 was the most productive. It had a lint yield of 1500 kg $ha^{-1}$. In general, the use of 100% or 150% of the recommended nitrogen (N), phosphorus (P) and potassium (K) dose increased fiber quality, though this did not apply to micronaire values. These values decreased with increased fertility in 70% of the analyzed cultivars. We concluded that the level of soil fertility affects cotton yield and fiber quality responses. We found that demanding cultivars may increase yield. However, increasing the dose of nutrients can increase the cost of production in less demanding cultivars.

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**KEYWORDS**
gin turnout; micronaire; soil fertility

## Introduction

Soil fertility is a crucial factor in reducing risks and increasing cotton yield (Zancanaro and Kappes 2012). With the emergence of genetic materials that provide greater yield potential, fine-tuning fertilization is fundamental to the successful cultivation of this crop. Different cultivars present variations in the absorption, translocation, and utilization of nutrients (Marschner, Kirkby, and Cakmak 1996). However, not all cultivars respond to high levels of fertilization. This is due to peculiarities and yield potential.

Cotton yield can be restricted by the amount of available nutrients in the soil, especially if the supply does not meet the requirements of the plant. Rochester (2007) reported that an increase in N, P, and K uptake of 54% (63–97 g $kg^{-1}$ fiber), 15% (13–15 g $kg^{-1}$ fiber), and 20.5% (77–93 g

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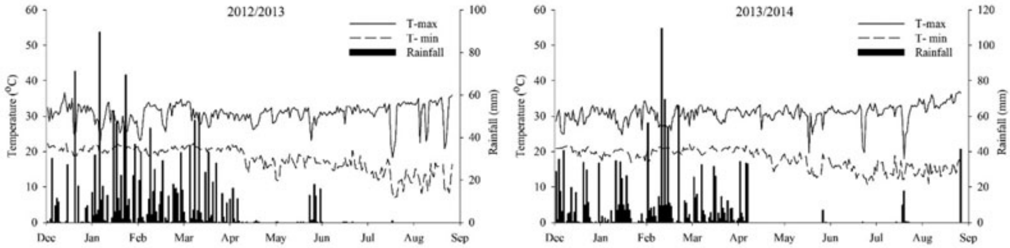


**Figure 1.** Rainfall and maximum and minimum temperatures in the 2012/2013 (right) and 2013/2014 (left) seasons that occurred during experiments in Primavera do Leste, Mato Grosso, Brazil.

$kg^{-1}$ fiber), respectively, allowed for yields from 1000 to 1800 kg $ha^{-1}$ of fiber. Nevertheless, proportionately, the quantity exported only increased from the N (21% – from 42 to 51 g $kg^{-1}$ fiber).

Nitrogen is critical for physiological processes, enzymatic activity, and fiber quality (Chen et al. 2010). Using an appropriate dose for cotton can improve plant growth, flowering, and yields (Carvalho, Ferreira, and Staut 2007). On the other hand, N deficiency causes premature senescence of the plants and reduces their yields (Dong et al. 2012).

Potassium is involved in different metabolic processes in cotton, such as enzymatic activity, stomatal control, photosynthesis, and photoassimilate transport. It improves the effects of the plant's abiotic and biotic defense mechanism. Appropriate K levels in the soil are a determinant in obtaining high yields (Oosterhuis, Loka, and Raper 2013). Hu et al. (2016a) argue that K requirements can vary between cultivars. Their research expressed the necessity to carry out specific studies for each material. In addition, K deficiency has detrimental indirect effects on the plant, such as a reduction of N assimilation. Findings from Lokhande and Reddy (2015) showed lower accumulations of biomass, boll numbers, and photosynthesis when cotton was cultivated in soils with a K deficiency.

Phosphorus is a nutrient related to the energy supply used in the production of photoassimilates (Fahad et al. 2016). Brazilian soils are poor in P, and the use of adequate levels of fertilization may improve the cultivar's yield (Withers et al. 2018). In addition to the direct benefits that this nutrient has on cotton, it can also be noted that P deficiency can reduce the absorption of N, K, and zinc (Duggan et al. 2009).

Hu et al. (2016b) evaluated three levels of K in cotton (0, 150, and 300 kg $ha^{-1}$) and two cultivars with different K deficiency sensitivities. They concluded that independent of the genotype, the optimal responses and accumulations of K in the plant were obtained with higher fertilizer doses. On the other hand, Luo et al. (2018) found that reducing the recommended dose of N by 30% did not affect crop yield. Thus, it is expected that modern cultivars can express various responses to different levels of soil fertility.

The objective of this work was to evaluate the impact of N, P, and K on the yield and fiber quality of cotton cultivars with different maturation cycles and chemical fertility gradients.

## Material and methods

### *Characterization of the experimental area*

The experiment was carried out in Primavera do Leste, Mato Grosso, Brazil (15°33'8"S and 54°11'46"O – 620 m altitude) in 2012/2013 and 2013/2014. According to Köppen's classification, the region has a tropical savannah climate (Aw). The region has an average annual temperature of 22 °C and receives 1784 mm of precipitation per year. Variables such as rainfall and maximum and minimum temperature were recorded during the conduction of the experiment and are shown in Figure 1. The soils of the areas were classified as typic dystrophic Tb Haplic Cambisol

**Table 1.** Physicochemical properties in the arable layer of the soil (0–20 cm) in the experimental areas during the 2012/2013 and 2013/2014 harvests.

| Year | SOM | pH | $P_{mehlich1}$ | K | Ca | Mg | CEC | Clay | Sand |
|---|---|---|---|---|---|---|---|---|---|
| | g dm$^{-3}$ | | mg dm$^{-3}$ | mmolc dm$^{-3}$ | | | | g kg$^{-1}$ | |
| 2012/2013 | 21.9 | 5.6 | 2.14 | 0.9 | 17.2 | 12.9 | 55.0 | 374 | 576 |
| 2013/2014 | 19.7 | 5.6 | 4.4 | 1.1 | 23.0 | 9.5 | 55.0 | 424 | 447 |

(FAO/WRB). The physicochemical properties of the soils are shown in Table 1. Soil samples were collected before cotton sowing. Soil analyses were performed according to the methodologies described by Raij et al. (2001). Lime and gypsum were applied with consideration of the results of the soil physicochemical analysis (Souza and Lobato 2004).

## Experimental setup

A randomized block design was used (13 × 3 factorial, cultivars × levels of fertility) with five replicates. The cotton cultivars included FM 910 (mid-cycle), FM 993 (late), IMA 12427 (mid-late), IMA 1595 (mid), IMA 1600 (mid), IMA 2059 (mid), IMA 278 (mid), IMA 2968 (mid), IMA 3869 (mid-late), IMA 474 (mid), IMA 6035 (mid-late), IMA 690 (mid-late), and IMA 8276 (late). Soil fertility was recorded with three levels of N, P, and K fertilization (50%, 100%, and 150% of the recommended dose of each nutrient).

## Soil fertilization and plant management

The criterion for establishing fertility levels was based on the official recommendations of Embrapa (Carvalho, Ferreira, and Staut 2007) and the Mato Grosso Foundation (Zancanaro and Kappes 2012). Nitrogen levels were determined according to the expected cotton yield. Phosphorus levels were calculated by the soil nutrient deficiency method and the interpretation tables for Cerrado soils. Potassium levels were calculated by the method of saturation of $K^+$ in the CEC at pH = 7, being 5.0% of K for 100.0% of recommended fertilization, 7.0% of K for 150.0%, and 3.6% of K for 50.0%.

Fertilization management (dosing and timing of application) is shown in Table 2. Urea, triple superphosphate, and potassium chloride were used as N, P, and K sources.

Sowing occurred on 12 December 2012 and 16 December 2013. Seeding density of 9 seeds m$^{-1}$ per row was used. The plots had four rows and were 7.0 m in length. They were spaced by 0.90 m. The sampled plot area was composed of two central rows. These two rows were 6.0 m in length. Cotton was sown on millet straw.

Weed management was conducted with nonselective herbicides prior to cotton implantation. Selective herbicides were used in the post-emergence period. Pest and disease management practices were carried out with insecticides and fungicides when needed. Growth regulators were applied when there was excessive vegetative growth. This occurred mainly at the highest levels of fertility.

Defoliation was performed using diuron + thidiazuron and pyraflufen base defoliants when the plants had 70% of their bolls. At the moment of the boll opening, the hormonal product Ethephon was applied. This occurred for 10 days after the defoliation.

## Plant sampling and analyses

The yield was determined through the mechanical harvesting of the two central rows of the plot. The mechanical harvesting was performed by a Picker harvester (Montana) with precision balance. The gin turnout was determined by separating cotton seeds from the fiber, and the values

**Table 2.** Doses of N, P, and K used in treatments in the crop years of 2012/13 and 2013/14.

| | N | | | $P_2O_5$ | | | $K_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|
| Timing | 50% | 100% | 150% | 50% | 100% | 150% | 50% | 100% | 150% |
| Pre-planting (millet) | – | – | – | – | 70 | 70 | – | 90 | 90 |
| Sowing | 10 | 20 | 30 | 70 | 70 | 140 | – | – | – |
| Top dressing at 20 DAE | 30 | 60 | 60 | – | – | – | 90 | 45 | 90 |
| Top dressing at 40 DAE | 30 | 60 | 60 | – | – | – | – | 45 | 90 |
| Top dressing at 60 DAE | – | – | 60 | – | – | – | – | – | – |
| Total (kg $ha^{-1}$) | 70 | 140 | 210 | 70 | 140 | 210 | 90 | 180 | 270 |

DAE: Days after emergence.

were expressed as percentages. The fiber quality analyses (micronaire, fiber length, fiber strength, and fiber maturity) were determined by the High Instrumentals Volume method. Cultivars were separated into three yield groups (>1000, >1200, and >1400 kg $ha^{-1}$ of lint). A summary of all characteristics was provided to analyze the behavior of all cultivars. We used the 100% recommended dose as a reference point.

### *Statistical data analyses*

We used a two-way ANOVA for statistical evaluation. Means were compared by Tukey's test at a 5% probability level. Sisvar statistical software was used, and the graphs were plotted on Sigmaplot®.

## Results

There was no interaction between the fertility levels, cultivars, and the crop years for the evaluated variables: ($p$ values=) 0.9758, lint yield; 0.6983, gin turnout; 0.2223, fiber length; 0.0914, fiber strength; 0.5455, micronaire; 0.1986, fiber maturity. The averages of the cultivars at each fertility level in the two-year study (2012/2013 and 2013/2014) were presented. The maturation cycles of the varieties had little effect on the demand for N, P, and K. However, there was a difference between the varieties for yield and fiber quality when comparing fertility levels.

Different fertility levels produced significantly different cotton fiber yields. Within the fertility level of 150%, the cultivar IMA 6035 was more productive than IMA 8276, with a yield of 1500 kg $ha^{-1}$ of lint. However, there was no observable difference among the other cultivars (Figure 2). In addition, the cultivars IMA 1600, IMA 3869, IMA 474, IMA 6035, and IMA 690 showed higher yields at the 150% level compared to the 50% level. However, these yields were the same as when the 100% recommended dose was used. The cultivars IMA 2059, IMA 2968, and IMA 8276 showed little or no response to increased fertility levels, but they produced above 1000 kg $ha^{-1}$ of lint. This showed that these genotypes are less responsive to increased soil fertility. This should be considered when selecting cultivars. Some cultivars, such as IMA 474, did not tolerate the reduction of fertilization. In these cases, we observed a 42% decrease in yield when the fertilization was reduced by 50%. In relation to the recommended dose, the same decrease occurred with IMA 690, IMA 6035, IMA 3869, and IMA 1600 (Figure 2).

The cultivars IMA 474, IMA 1600, and IMA 278 presented the highest increases in yield when the fertility level rose from 50% to 100%, with percentage increases of 42%, 22%, and 20% respectively. The cultivars IMA 2968, IMA 8276, and IMA 12427 presented the smallest increases in productivity (1%, 7%, and 9%, respectively).

Increasing the recommended dose from 100% to 150% reduced the yields by 2% in cultivars IMA 2059 and IMA 8276. Additionally, IMA 278, IMA 12427, and IMA 474 genotypes were almost nonresponsive (1%, 1%, and 3%, respectively). In addition, when the dose increased from

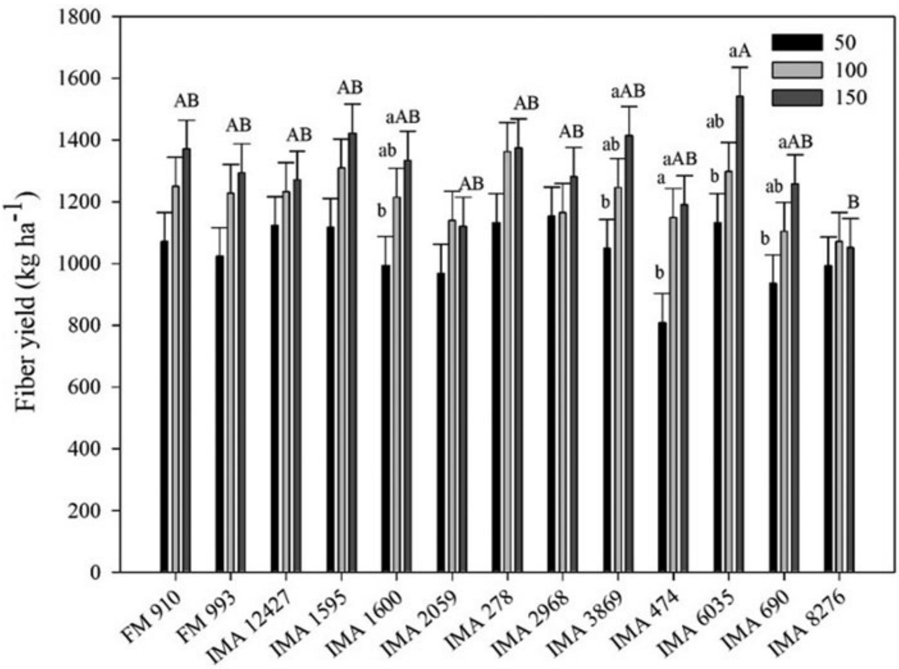


**Figure 2.** Lint yield of cotton cultivars at different fertility levels. The treatments shown represent the average of two crop years (2012/2013 and 2013/2014). The averages followed by upper case letters within each fertility level showed statistical difference. The averages followed by lower case letters within each cultivar showed statistical difference. Tukey's test with 5% probability ($p < 0{,}05$) was used.

100% to 150%, the cultivars IMA 6035, IMA 690, and IMA 3869 had increases in yields of 18%, 13%, and 13%, respectively.

The most responsive cultivars to fertilization levels were IMA 6035, IMA 1595, and IMA 278 (Table 3). These cultivars were also the most productive when using the recommended fertilization rate or half of it. However, the cultivar IMA 3869 performed better when grown in an environment that received the recommended or higher fertilization level. The cultivars IMA 12427 and FM 910 performed better under low fertilization levels or when the recommended dose was used. In addition, cultivar IMA 2968 performed well with low fertility levels, and IMA 1600 was most responsive to the recommended fertilization dose (Table 3).

Only the gin turnouts of cultivars IMA 2968 and IMA 690 were influenced by the genotype x fertility level interaction. Both showed higher gin turnout at the lower fertility level (Figure 3).

Raising the fertility level from 50% to 150% increased the fiber length (4%) in the cultivar IMA 12427. The genotype IMA 690 presented similar fiber lengths at the 50% and 150% levels. These were both higher than at the 100% level. Furthermore, when compared to IMA 690, fiber lengths were higher when the recommended dose was used in the cultivars FM 910, IMA 12427, IMA 1595, IMA 1600, IMA 278, IMA 2968, IMA 3869, and IMA 474 (Figure 4).

Fiber strength was reduced with increases to the fertility level in the cultivar IMA 3869. Moreover, with the 100% fertility level, the cultivar IMA 12427 presented lower fiber strength when compared to cultivar FM 910 (Figure 5).

The increase in fertility levels reduced the micronaire values in most of the evaluated cultivars, with the exception of the cultivars IMA 1595, IMA 1600, IMA 3869, and IMA 6035 (Figure 6).

The genotypes presented different responses regarding fiber maturity at the different fertility levels studied. Most of the cultivars were not affected by the level of fertilization. However, IMA 1595, IMA 1600, IMA 6035, and IMA 690 presented higher maturity with the 100% fertility level (Figure 7).

**Table 3.** Fiber yield classification of cotton cultivars regarding the responsiveness to the increase in chemical soil fertility level through NPK fertilizer.

| | Fiber yield level (kg ha$^{-1}$) | | |
|---|---|---|---|
| Cultivars | >1000 | >1200 | >1400 |
| IMA 6035 | ■ | ■ | ■ |
| IMA 1595 | ■ | ■ | ■ |
| IMA 278 | ■ | ■ | ■ |
| IMA 3869 | | ■ | ■ |
| IMA 12427 | ■ | ■ | |
| FM 910 | ■ | ■ | |
| IMA 2968 | ■ | | |
| IMA 1600 | | ■ | |

Productivity levels greater than 1000, 1200, and 1400 kg ha$^{-1}$ of fiber were used to discriminate the genotypes in each fertility level of 50%, 100%, and 150% of the recommended dose, respectively. The treatments shown represent the average of the two crop years (2012/2013 and 2013/2014).

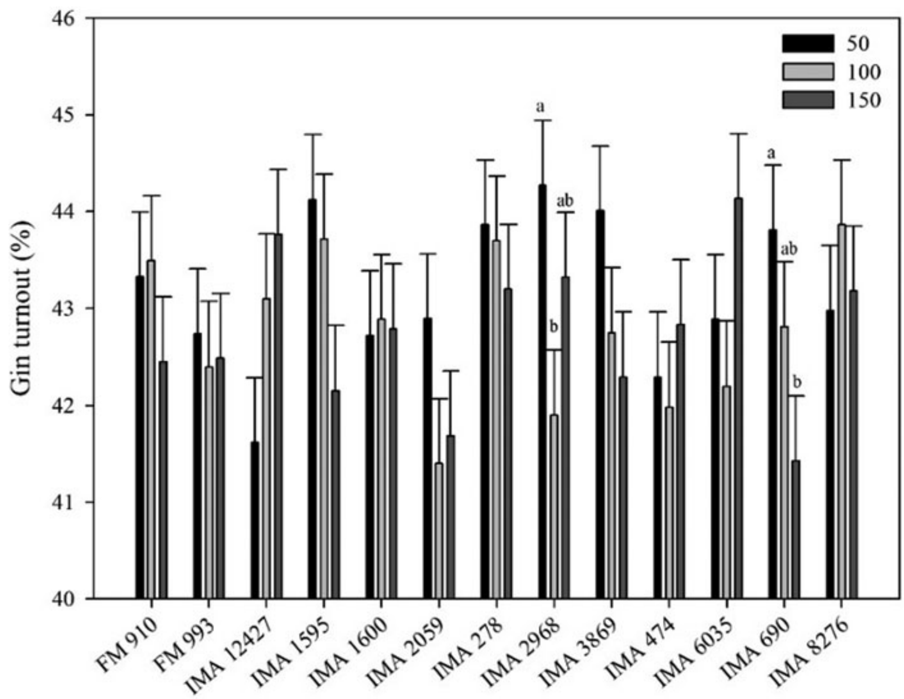


**Figure 3.** Gin turnout of cotton cultivars at different fertility levels. The treatments shown represent the average of the two crop years (2012/2013 and 2013/2014). Means followed by lowercase letters within each cultivar show statistical difference. Tukey's test with 5% probability ($p < 0.05$) was used.

At the low fertilization level, only cultivar IMA 2968 showed similar yield performance when compared to the recommended dose. Eight of the 13 evaluated cultivars demonstrated improved yields when the level of fertilization was raised from 100% to 150%. Most of the cultivars (11 of 13) presented an increase or stability in the lint yield when submitted to a low fertilization level. Six of the 13 cultivars had a reduction of this characteristic when exposed to the increase of the fertilizer dose. Nine of the 13 cultivars maintained their fiber strength under high or low fertilization levels. This shows that this variable (as well as maturity) is less affected by fertilization (Table 4).

When exposed to an increase in fertilization level, fiber lengths improved in 7 of the 13 cultivars. In addition, 6 of the 13 cultivars presented stability in terms of fiber length under low fertilization levels. Eight of the 13 cultivars presented a reduction in micronaire values when

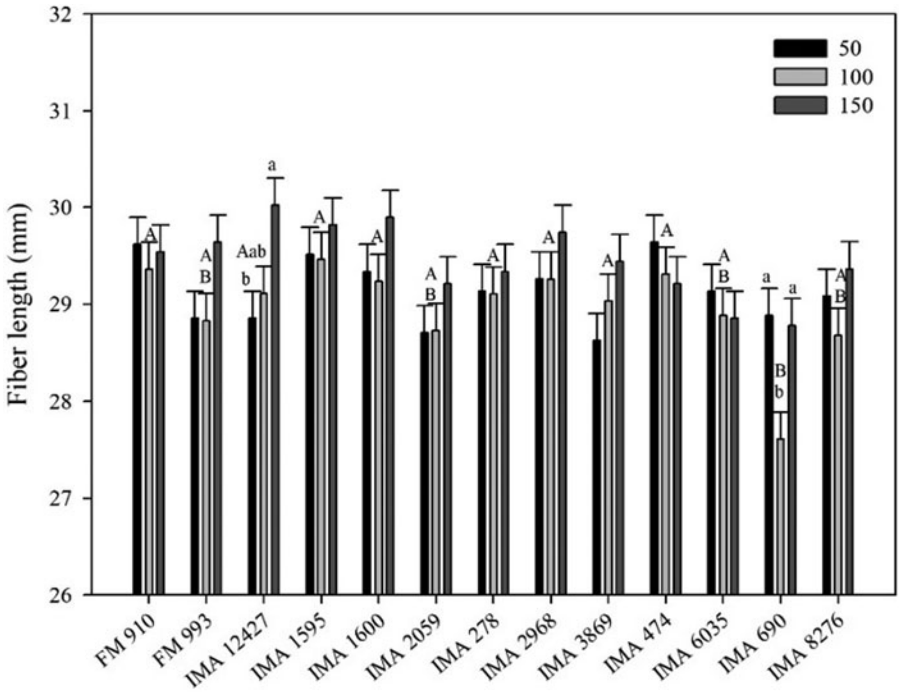


**Figure 4.** Fiber lengths of cotton cultivars at different fertility levels. The treatments shown represent the average of the two crop years (2012/2013 and 2013/2014). The averages followed by uppercase letters within each fertility level showed statistical difference. The averages followed by lowercase letters within each cultivar showed statistical difference. Tukey's test with 5% probability ($p < 0.05$) was used.

submitted to the highest level of fertilization. Ten cultivars had an increase in micronaire values when cultivated at low fertilization levels (Table 4).

## Discussion

The genotypes presented different responses to soil fertility levels. They showed that management of fertilization should be adjusted according to the cultivar selected by the farmer. The cultivar IMA 6035 showed a good response to increased NPK fertilization. It was the most productive at the fertility level of 150% (Figure 2). A similar result was obtained by Meena, Meena, and Kumhar (2017). Their cotton cultivars presented a differentiated productive performance with fertility levels of 75%, 100%, and 125% of the recommended NPK dose. The highest yields were obtained at levels of 100% and 125%. In addition, cultivar H-8 was 24% more productive than cultivar RAHH-259. Vieira et al. (2018) observed that cotton cultivars that received 100% of the recommended dose did not differ in nutrient absorption per ton of fiber produced. The yields were affected by the production environment (Mato Grosso and Bahia), though the authors did not report the cultivar yield in these environments.

Some cultivars, such as IMA 474, did not tolerate the reduction of fertilization. They showed a 42% decrease in yield when the fertilization was reduced by 50% of the recommended dose. The same decrease occurred with IMA 690, IMA 6035, IMA 3869, and IMA 1600. Nine of the 13 evaluated cultivars had the highest fiber length at the 150% fertility level (Figure 4). This demonstrated that increased soil fertility has a direct effect on fiber quality. This may be directly related to the K supply, since this nutrient plays a crucial role on the quality of the cotton fiber (Mullins and Burmester 1990).

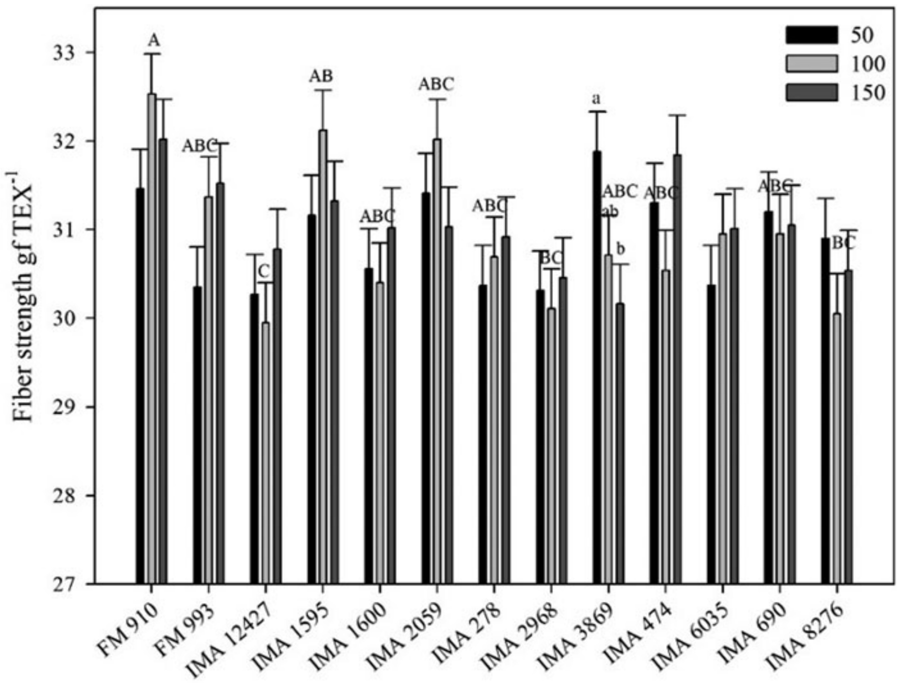


**Figure 5.** Fiber strength of cotton cultivars at different fertility levels. The treatments shown represent the average of the two crop years (2012/2013 and 2013/2014). The averages followed by uppercase letters within each fertility level showed statistical difference. The averages followed by lower case letters within each cultivar showed statistical difference. Tukey's test with 5% probability ($p < 0.05$) was used.

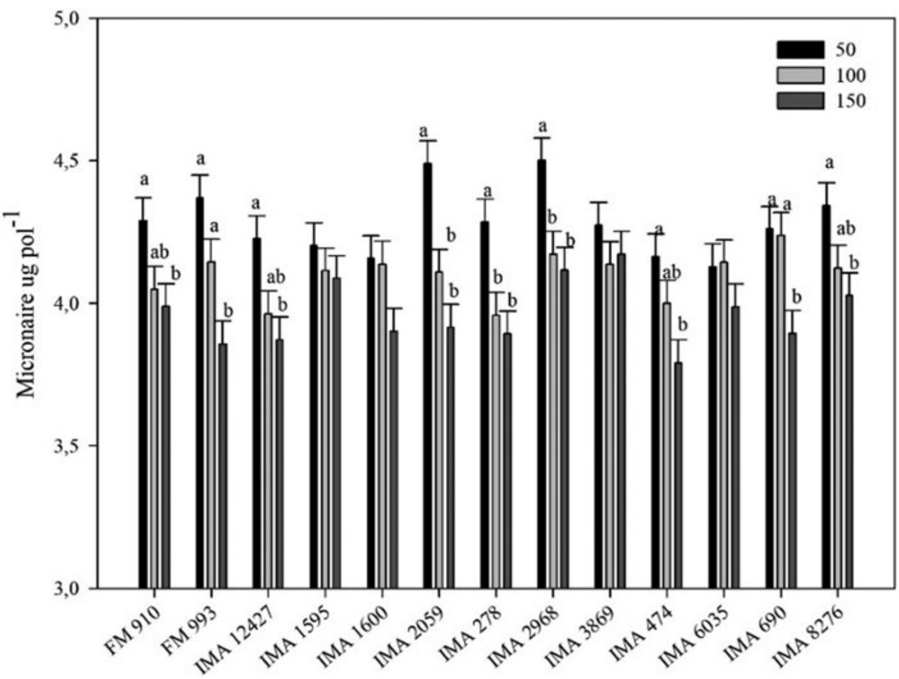


**Figure 6.** Micronaire values of cotton cultivars at different fertility levels. The treatments shown represent the average of the two crop years (2012/2013 and 2013/2014). Means followed by lowercase letters within each cultivar showed statistical different. Tukey's test with 5% probability ($p < 0.05$) was used.

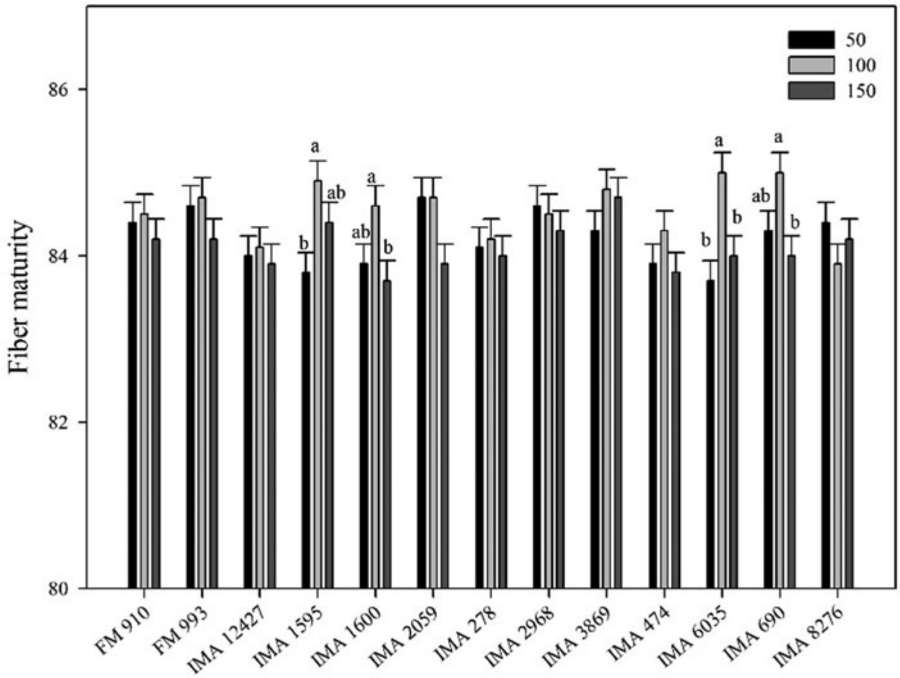


**Figure 7.** Fiber maturity of cotton cultivars at different fertility levels. The treatments shown represent the average of the two crop years (2012/2013 and 2013/2014). Means followed by lowercase letters within each cultivar showed statistical difference. Tukey's test with 5% probability ($p < 0.05$) was used.

**Table 4.** Cotton cultivar behavior in relation to the soil fertility levels when compared to recommended fertilization levels (100% dose).

| | Lint yield | | Gin turnout | | Fiber Strength | | Fiber length | | Micronaire | | Maturity | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Levels of fertilization | | | | | | | | | | | |
| Cultivar | L | H | L | H | L | H | L | H | L | H | L | H |
| FM 910 | Black | Dark gray | Light gray | Black | Black | Black | Light gray | Light gray | Dark gray | Light gray | Light gray | Light gray |
| FM 993 | Black | Dark gray | Light gray | Light gray | Black | Light gray | Light gray | Dark gray | Dark gray | Black | Light gray | Black |
| IMA 12427 | Black | Light gray | Black | Dark gray | Dark gray | Dark gray | Black | Dark gray | Dark gray | Black | Light gray | Light gray |
| IMA 1595 | Black | Dark gray | Light gray | Black | Black | Black | Light gray | Dark gray | Dark gray | Light gray | Black | Black |
| IMA 1600 | Black | Dark gray | Light gray | Light gray | Light gray | Dark gray | Light gray | Dark gray | Light gray | Black | Black | Black |
| IMA 2059 | Black | Light gray | Dark gray | Light gray | Black | Black | Light gray | Dark gray | Dark gray | Black | Light gray | Black |
| IMA 278 | Black | Light gray | Light gray | Black | Light gray | Light gray | Light gray | Light gray | Dark gray | Light gray | Light gray | Light gray |
| IMA 2968 | Light gray | Dark gray | Dark gray | Dark gray | Light gray | Light gray | Light gray | Dark gray | Dark gray | Light gray | Light gray | Light gray |
| IMA 3869 | Black | Dark gray | Dark gray | Black | Dark gray | Black | Black | Dark gray | Dark gray | Light gray | Black | Light gray |
| IMA 474 | Black | Light gray | Light gray | Dark gray | Dark gray | Dark gray | Dark gray | Light gray | Dark gray | Black | Light gray | Light gray |
| IMA 6035 | Black | Dark gray | Dark gray | Dark gray | Black | Light gray | Dark gray | Light gray | Light gray | Black | Black | Black |
| IMA 690 | Black | Dark gray | Dark gray | Black | Light gray | Light gray | Dark gray | Dark gray | Light gray | Black | Black | Black |
| IMA 8276 | Black | Light gray | Black | Black | Dark gray | Dark gray | Dark gray | Dark gray | Dark gray | Black | Light gray | Light gray |

L: low (50% of the recommended dose) and H: high (150% of the recommended dose). Black fill: reduction; light gray: stable; dark gray: increase.

Cassman et al. (1989) worked with doses of K in two cotton cultivars (0, 120, 240, and 480 kg $ha^{-1}$). A linear increase in cotton seed yield was reported. However, in the control treatment, the cultivar GC510 was 32% more productive than the SJ2 cultivar. This suggests greater efficiency from the use of K.

Lokhande and Reddy (2015) concluded that the reduction of K fertilization (100–0% of the recommended dose) decreases the biomass production of cotton by 28%. Furthermore, it linearly reduces fiber lengths, micronaire values, and yields. In contrast, 92% of the evaluated cultivars had higher micronaire values with 50% of the recommended fertilization dose (Figure 6). According to Heitholt (1997), this occurs due to the reduction of fruiting areas of the plant, which decreases the internal competition of the plant by assimilates. This leads to higher cellulose deposition in the secondary wall of the fiber. This is reflected in the increase of the micronaire.

Borin et al. (2017) studied the response of the FM 966LL cotton cultivar in a second harvest system in soil with K levels similar to that of the present experiment (1.1 mmolc $dm^{-3}$) with N and K. They found a quadratic response for both nutrients, and the maximum yield (about 1100 kg $ha^{-1}$ of lint) occurred with the doses of 100 and 40 kg $ha^{-1}$ of N and K, respectively. Comparatively, in the present experiment, several cultivars reached similar productive levels to those observed by Borin et al. (2017) at the fertility level of 50% of the recommended dose. This showed that in addition to the difference between the cultivars, the production environment and the cultivation system may also affect the fertilization response. In soybeans, Borghi et al. (2017) reported different responses of the genotypes to the degree of investment in fertilization. They reported that in environments of lower fertility, only more rustic genotypes were capable of reaching yields that were higher than the state average.

In a study with various nitrogen fertilization levels (0, 56, 112, 168, and 224 kg $ha^{-1}$) and three cultivars of different maturation cycles, McConnel et al. (1993) did not report a difference in cultivar yields. However, they concluded in their three-year experiment that 112 kg $ha^{-1}$ was the optimal dose. This dose produced on average 3753 kg $ha^{-1}$ of cotton seed. In this study, the most productive cultivar was IMA 6035 (3409 kg $ha^{-1}$ of cotton seed) at the level of 150% or 210 kg $ha^{-1}$ of N. This fact may be associated with low water availability (Figures 1 and 2) or the limited availability of radiation. This was caused by excessive cloudy days in the period of maximum N absorption. This interfered with the efficiency of N use, as observed by Pan et al. (2016) in rice cultivars. Under these conditions of reduced radiation, yields were compensated by the increase in the dose of N. Thus, the response to the increase in the dose of N is related to the production environment and genotypic characteristics (Rosolem, Foloni, and Oliveira 2003; McConnel et al. 1993). This is particularly relevant in tropical environments that have sandy and low pH soils, and receive more than 1500 of rainfall per year concentrated in the summer months.

Fritschi et al. (2003) studied the effect of nitrogen fertilization levels and cultivars. They concluded that cultivars presented different responses to N rates. Pima showed quadratic behavior (higher yields with 168 kg $ha^{-1}$ of N). The cultivar Acala showed a linear increment with the increase in the N rates. Additionally, it was reported that the productivity of the cultivar Acala was higher in soils with clay textures due to the greater residual content of available N. However, it is worth noting that these specific results come from soil with a clay content of around 40%. The same reactions should not be expected from sandy soils (<15% clay). Due to their lower organic matter content, sandy soils tend to be more responsive to the increase in N fertilization.

Regarding the quality of fiber, Fritschi et al. (2003) found that N rates did not influence fiber strength or affect micronaire values. This was similar to the present study regarding fiber strength in most cultivars (except for IMA 3869). However, in this present study, there was a reduction in micronaire values when the level of fertility increased. This was related to the lower number of fruiting points observed when the plants received only 50% of the recommended NPK dose.

## Conclusion

The cultivars showed different responses to NPK levels, and the most responsive to the increase in fertilization were IMA 6035, IMA 1595, and IMA 278. These cultivars also remained distinctive at the lowest level of fertilization. Increasing the fertilization level reduced the gin turnout, but it did not affect the strength or maturity in most evaluated cultivars. The increase in the fertilization level improved the fiber length in 53% of the tested cultivars. Stable lengths were maintained in 46% of the cultivars that were exposed to low fertilization levels. The increase in fertility levels reduced micronaire values. The reduction of fertilization levels increased the micronaire values in the vast majority of the analyzed cultivars. Generally, when choosing a cultivar, investment in fertilizers should be strongly considered, as cultivars have different responses in both the yield and fiber quality.

## Disclosure statement

There are no conflicts of interests to declare.

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