PHYSIOLOGICAL PARAMETERS OF COTTON CULTIVARS IN WEST PAULISTA

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ABSTRACT:

Cotton varieties develop differently because they present different physiological characteristics in production environments. This study aimed to know the physiological characteristics of cotton. The experiment was carried out at the São Paulo Agribusiness Technology Agency (APTA), Alta Paulista region. The experimental design used was Entirely Randomized (DIC), with six cotton cultivars: IMA5801B2RF; FM975WS; TMG47B2RF; TMG81WS; FM944GL and IACRDN. Where the following physiological parameters were determined: Assimilation rate CO_2, leaf transpiration, stomatal conductance, internal concentration of CO_2 in the substomatic chamber and efficient use of water. The cotton varieties showed different physiological characteristics, the IMA5801B2RF variety had the lowest performance, which may reflect low productivity. Further physiological studies are needed to understand the Cotton varieties behavior

Keywords: *Gossypium hirsutum*; plant physiology; transpiration; stomatal conductance.

PARÂMETROS FISIOLÓGICOS DE CULTIVARES DE ALGODOEIRO NO OESTE PAULISTA

RESUMO:

As variedades de algodão se desenvolvem de maneiras diferentes, por apresentar características fisiológicas diferentes nos ambientes de produção. Este estudo teve como objetivo conhecer as características fisiológicas do algodão. O experimento foi realizado na Agência Paulista de Tecnologia do Agronegócio (APTA), região da Alta Paulista. O delineamento experimental utilizado foi inteiramente casualizado (DIC), com seis cultivares de algodão: IMA5801B2RF; FM975WS; TMG47B2RF; TMG81WS; FM944GL e IACRDN. Onde foram determinados os seguintes parâmetros fisiológicos: Taxa de assimilação de CO_2, transpiração foliar, condutância estomática, concentração interna de CO_2 na câmara subestomática e uso eficiente da água. As variedades de algodão apresentaram características fisiológicas distintas, sendo que a variedade IMA5801B2RF apresentou o pior desempenho, o que pode refletir baixa produtividade. Mais estudos fisiológicos são necessários para entender o comportamento das variedades de algodão.

Palavras-chave: *Gossypium hirsutum*; fisiologia vegetal; transpiração; condutância estomática.

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INTRODUCTION

Cotton (*Gossypium hirsutum* L. r. *Latifolium Hutch*) is among the most important fibrous crops in the world, with a cultivated area of approximately 35 million hectares. In Brazil, in the 2017/2018 harvest, 1.17 million hectares of cotton were grown with an average yield of 1,677 kg ha^{-1} of plume, with Brazil being the second largest world producer of fiber (Abrapa, 2019). Feather production in the 2018/2019 harvest is expected to reach 2.4 million tonnes, with an increase of 20% over the previous harvest (Conab, 2019).

The main cotton producing states in Brazil are Mato Grosso and Bahia, representing about 80% of the cultivation area in the country, the main characteristics of these regions being medium and sandy soil. In the state of São Paulo the West is the second largest producing micro-region with around 1,800 hectares of crop in the 2018/2019 harvest (Appa, 2019).

Cotton, among the plants cultivated by man, is one of the most complex, being very demanding in management practices and for having a set of particular physiological characteristics (Beltrão, 2006). The physiology is affected by environmental factors, with the water status in plants being one of the main factors that affect leaf growth, it is extremely important for agricultural production (Taiz et al., 2017).

The great diversity in upland cotton allows it to be cultivated in two regions of Brazil (Central-West and Northeast). The magnitude of genotype X environment interaction across most traits complicates selecting the best variety (Teodoro et al., 2019). Therefore, this study aimed to know the physiological characteristics of cotton.

MATERIAL AND METHODS

The experiment was carried out in December 2018, at the São Paulo Agribusiness Technology Agency (APTA), Alta Paulista region, located in Adamantina city, State of São Paulo, with geographical coordinates 21°40'24.024"S and 51°8'31.088"W and an approximate altitude of 420 m. The region's climate is characterized as Aw according to Köppen and Geiger, it has rainy summers and dry winters; with an annual average temperature of 22.1 °C and 1204 mm of accumulated rainfall in the year.

The experimental design used was Entirely Randomized (DIC), with six cotton cultivars: IMA5801B2RF; FM975WS; TMG47B2RF; TMG81WS; FM944GL and IACRDN.

The soil was classified as Argisol red-yellow dystrophic (Embrapa et al., 2013) with good drainage and its chemical attributes, after analysis (Raij et al., 1996) are shown in Table 1.

Table 1 – Chemical attributes of the soil in the experiment area when sowing cotton. Adamantina, 2018.

pH	OM	P	K	Ca	Mg	H+Al	Al	SB	CEC	V%	m%
CaCl$_2$	g dm^{-3}	mg dm^{-3}	---------------------------- mmol$_c$ dm^{-3} -------------------------								
4.6	12.0	26.0	2.9	8.0	4.0	20.0	1.0	14.9	34.9	43.0	6.0

OM: Organic matter; SB: Sum of bases; CEC: Cation exchange capacity; V%: Base saturation; m%: Saturation by aluminum.

The soil was corrected according to the requirements of the crop according to Fuzatto et al. (2014), where the 300 kg ha^{-1} planting fertilizer was used with the NPK fertilizer 08-28-16 and was applied 1.0 t ha^{-1} of dolomitic limestone for liming the soil. Each plot had six lines five meters long, with a density of six plants per linear meter.

At 70 days after sowing, the first fully expanded leaf was selected at random from the apex of five plants within each plot, and five measurements were taken per plant, totaling 25 measurements per cotton variety, where the following parameters were determined physiological: Assimilation rate CO_2 (A – µmol CO_2 m^{-2} s^{-1}), Leaf transpiration (E – mmol H_2O m^{-2} s^{-1}), Stomatal conductance (GS – mol H_2O m^{-2} s^{-1}), Internal concentration of CO_2 in the substomatic chamber (Ci – µmol mol^{-1}) and Efficient use of water (EUW – mol CO_2 mol H_2O^{-1}), determined through the formula:

$$EUW = \frac{A}{E}$$

The initial condition for the measurement was according to the luminous intensity of the environment in the period between 10:00 am to 2:00 pm in full sun, where the equipment of Gas and Infrared Analyzer (IRGA), brand ADC BioScientific Ltd, model LC-Pro. Where five measurements were made in five plants, making up 25 measurements per variety.

For statistical evaluation of treatments, the variables were subjected to analysis of variance by the F test (p<0.05) and their means compared by the Skott-Knott test at 5% probability (Banzatto and Kronka, 2013) and the program was used statistic R (R Core Team, 2009).

RESULTS AND DISCUSSION

According to analysis of variance (Table 2), it was observed that there was a statistical difference for all physiological characteristics, analyzed in this research, of cotton cultivars cultivated in West Paulista.

Table 2 – Analysis of variance of the CO_2 assimilation rate (A), Transpiration (E), Stomatal conductance (GS), and Internal CO_2 concentration in the substomatic chamber (Ci) and efficient use of water (EUW) of the cotton cultivars. Adamantina, 2018.

	A	E	GS	Ci	EUW
p value	0.0077	0.0015	0.0001	0.0020	0.0391
Meaningfulness	**	**	**	**	*
Mean standard error	0.57	0.08	0.04	4.36	0.15

According to Pimentel (1998) the C3 plants, which is the case of cotton, show photosynthetic activity in an interval between 12 and 25 µmol m^{-2} s^{-1}. By analyzing the CO_2 assimilation rate results presented in Figure 1, it can be seen that the values of the cotton cultivars are within the acceptable parameters mentioned above. The cultivar TMG81WS had the lowest averages for a CO_2 assimilation rate, while the other cultivars had averages between 23.12 and 21.72 µmol CO_2 m^{-2} s^{-1}.

Regarding cotton leaf transpiration, the cultivars IMA5801B2RF, FM975WS and TMG47B2RF had the highest values, with averages between 3.61 to 3.55 mmol H_2O m^{-2} s^{-1} (Figure 2). The other cultivars had approximately 8.5% less sweat. The low results presented by cultivars TMG81WS, FM944GL, IACRDN, demonstrate a greater water retention capacity exhibited by these cultivars, probably due to the stomatal mechanism (Marur and Faria, 2006).

Sweating is highly affected by environmental factors, especially temperature and the deficit in air saturation. Differences in this parameter, when the plants are grown under similar conditions, can demonstrate an efficient or less efficient stoma apparatus, effective in saving water for the plant (Xiong et al., 2018; Lisboa et al., 2019).

In the evaluation of stomatal conductance, the variety IMA5801B2RF presented the highest values (1.22 mol H_2O m^{-2} s^{-1}), standing out from the other cultivars the according Figure 3. Low indices of stomatal conductance leads to a lower influx of CO_2 into the chloroplasts, so there will be reductions in

photosynthetic rates (Tatagiba et al., 2015). Low values of stomatal conductance (gs) indicates that photosynthesis would not be affected by stomatal closure or by the concentration of CO_2 within the sub-stomatal chamber, but by biochemical factors that would be restricting CO_2 reduction (Marur and Faria, 2006). Galon et al. (2010) reported that stomatal conductance and CO_2 level are directly associated with stomata opening, that is, the higher the stomatal conductance the greater the number of open stomata and consequently there will be greater assimilation of CO_2.
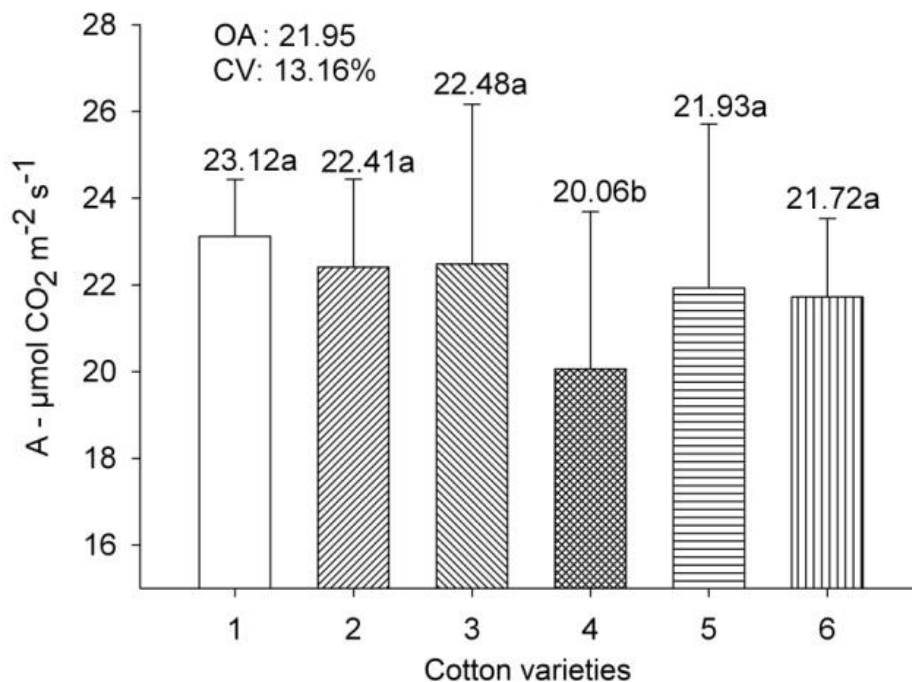

Figure 1. Average values of the CO_2 assimilation rate (A) of the physiological characteristics of cotton cultivars. OA= Overall average; CV = Coefficient variation. 1 - IMA5801B2RF; 2 - FM975WS; 3 - TMG47B2RF; 4 - TMG81WS; 5 - FM944GL and 6 - IACRDN.
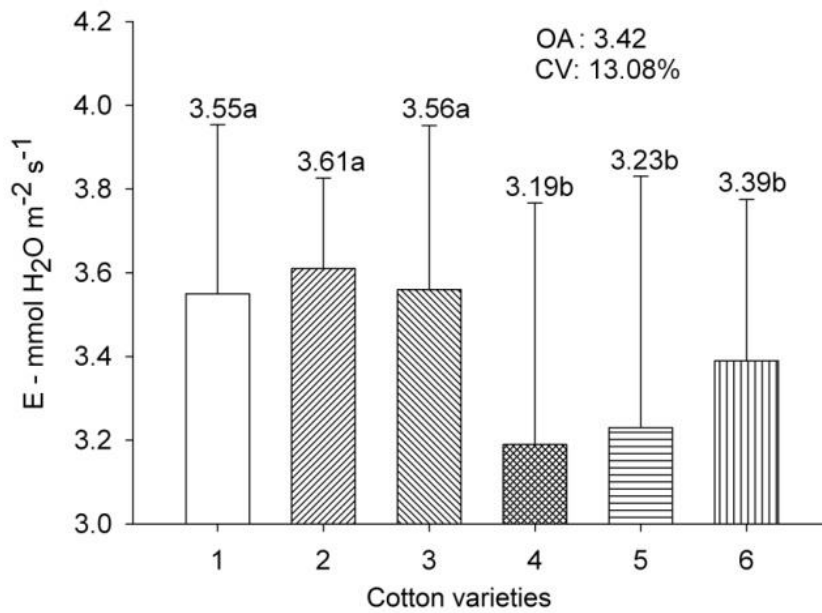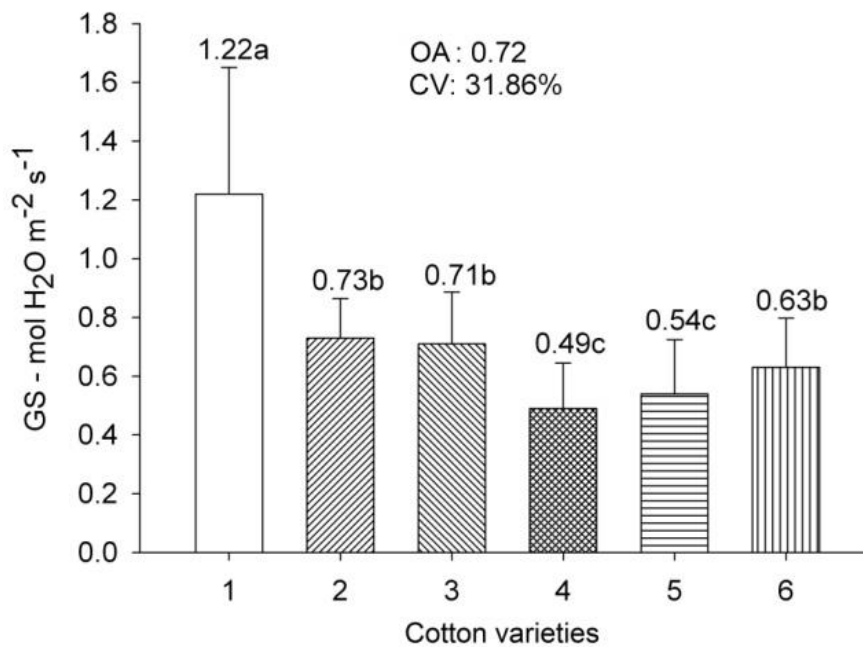
Figure 2. Average values of leaf transpiration (E) of cotton cultivars. OA= Overall average; CV= Coefficient variation. 1 - IMA5801B2RF; 2 - FM975WS; 3 - TMG47B2RF; 4 - TMG81WS; 5 - FM944GL and 6 - IACRDN.

Figure 3. Average values of stomatal conductance (GS), of cotton cultivars. OA= Overall average; CV= Coefficient variation. 1 - IMA5801B2RF; 2 - FM975WS; 3 - TMG47B2RF; 4 - TMG81WS; 5 - FM944GL e 6 - IACRDN.

The cotton cultivars IMA5801B2RF, FM975WS, TMG47B2RF and IACRDN had higher averages for the internal concentration of CO_2 in the substomatic chamber. The lowest values were 248.96 and 251.64 μmol mol^{-1} for cultivars TMG81WS and FM944GL respectively (Figure 4). The internal CO_2 concentration corresponding to the zero balance between the amounts of CO_2 entering and leaving the sub-stomatal chamber and defining the CO_2 compensation point (Machado et al., 2005). Stomatal limitation would negatively affect photosynthetic performance, given that the greater the stomatal opening, the greater the diffusion of CO_2 into the substomatic chamber (Silva et al., 2015).
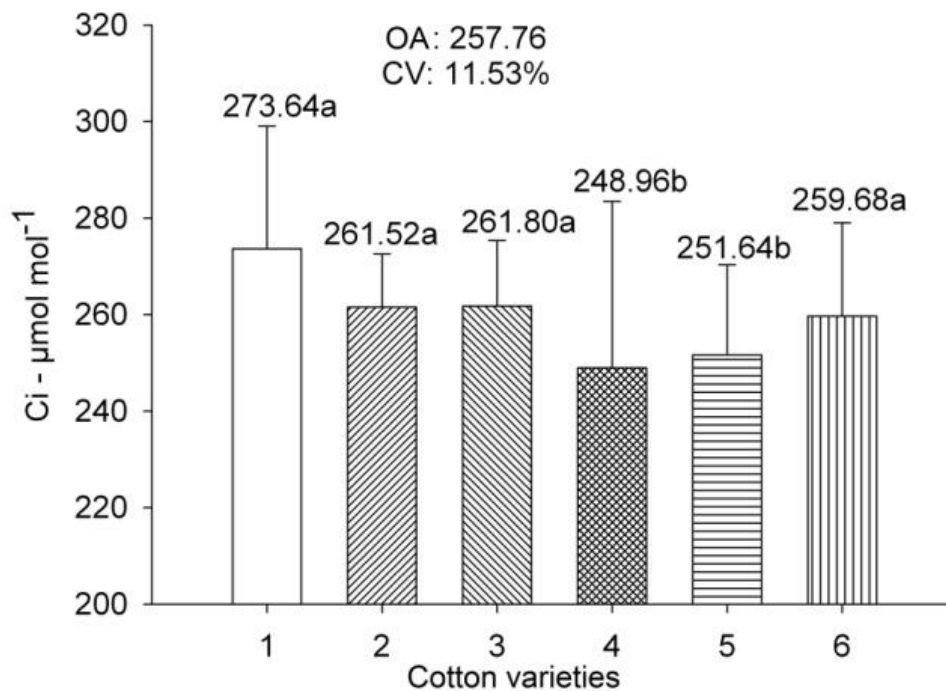

Figure 4. Average values of the internal CO_2 concentration in the substomatic chamber (Ci) of cotton cultivars. OA= Overall average; CV= Coefficient variation. 1 - IMA5801B2RF; 2 - FM975WS; 3 - TMG47B2RF; 4 - TMG81WS; 5 - FM944GL e 6 - IACRDN.

The cultivars that showed the best efficient use of water were IMA5801B2RF, FM944GL and IACRDN with values between 6.45 to 6.66 mol CO_2 mol H_2O^{-1} according to the Figure 5. The other cultivars had values of 6% lower approximately. The efficiency of water use in plants is correlated with the functioning of the stomatal apparatus, since this trait refers to the ratio between the amount of CO_2 assimilated and the amount of water transpired by the plant (Lisboa et al., 2019). This trait of plants is an extremely important variable, as it is said the plant's capacity to resist drought conditions and irregular distribution, as well as excess water (Perazzo et al., 2013).
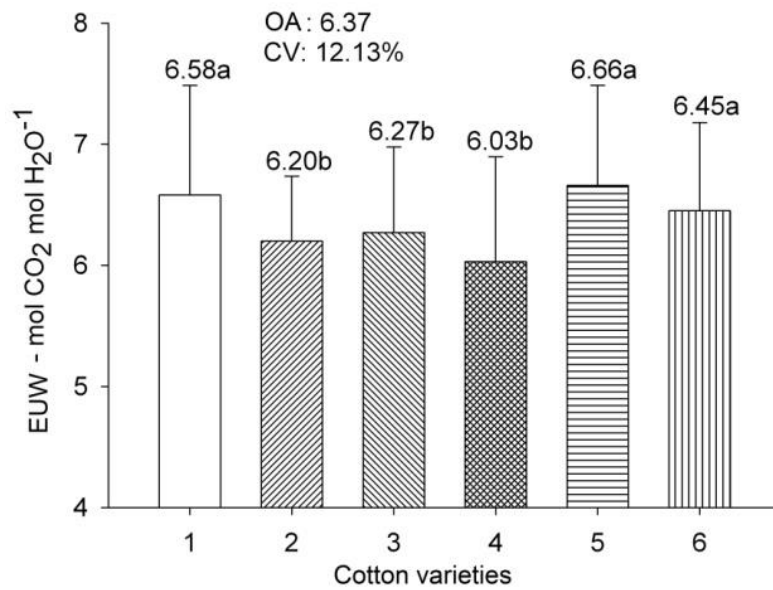
Figure 5. Average values of efficient use of water (EUW) of the physiological characteristics of cotton cultivars. OA= Overall average; CV= Coefficient variation. 1 - IMA5801B2RF; 2 - FM975WS; 3 - TMG47B2RF; 4 - TMG81WS; 5 - FM944GL e 6 - IACRDN.

CONCLUSION

The cotton varieties showed different physiological characteristics, where the IMA5801B2RF variety had the lowest performance, which may reflect low productivity.

Further physiological studies are needed to understand the behavior of cotton varieties.

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