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GAS EXCHANGE AND MORPHOMETRIC CHARACTERISTICS OF BASIL ACCORDING TO THE TIMES AND COLLECTION POSITIONS IN THE PLANT

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ABSTRACT – The productive potential of plant species depends on the genotype versus environment interaction, so the choice of cultivar is decisive for the success of the crop. Thus, the objective of this work was to evaluate the levels of photosynthetic pigments and morphometric characteristics of two cultivars of green and red basil as a function of the collection time and different collection positions in the plant, as well as the gas exchange in response to variation of the flux density of photosynthetically active photons. The experiment was carried out in a protected environment with a randomized block design in a 2 x 3 x 3 factorial scheme containing 2 treatments consisting of two basil cultivars (*alfavaca basilicão*, red and green) and fifteen replications. The first factor was constituted by the cultivars, the second, by the time of collection, and the third, by the positions in which the collections were carried out on the plant. For evaluations of morphometric variables and gas exchange rates, the two cultivars were compared. Basil has photosynthesis saturation at radiation rates of about 1500 μmol m^{-2} s^{-1}. The green colored cultivar was more productive, in addition to having the highest levels of chlorophyll *a*, *b* and *total*, and lower rate of leaf transpiration in response to photosynthetically active photons flow density, adapted for greater carboxylation efficiency and water use.
Keywords: *Ocimum basilicum* L., cultivars, net assimilation rate.

TROCAS GASOSAS E CARACTERÍSTICAS MORFOMÉTRICAS DE MANJERICÃO, EM FUNÇÃO DA ÉPOCAS E POSIÇÕES DE COLETA NA PLANTA

RESUMO - O potencial produtivo de espécies vegetais depende da interação genótipo x ambiente, sendo assim, a escolha da cultivar é decisiva para o sucesso do cultivo. Deste modo o objetivo do trabalho foi avaliar os teores dos pigmentos fotossintéticos e características morfométricas de duas cultivares de manjericão do tipo verde e vermelho, em função da época de coleta e diferentes posições de coleta na planta, bem como as trocas gasosas em resposta à variação da densidade de fluxo de fótons fotossinteticamente ativos. O experimento foi conduzido em ambiente protegido, com delineamento experimental de blocos ao acaso, em esquema fatorial 2 x 3 x 3, contendo 2 tratamentos constituídos por duas cultivares de manjericão (alfavaca basilicão de coloração vermelha e verde) e quinze repetições. O primeiro fator foi constituído pelas cultivares, o segundo pela época de coleta e o terceiro pelas posições em que as coletas foram realizadas na planta. Para as avaliações das variáveis morfométricas e índices de trocas gasosas foram realizadas comparações entre as duas cultivares. O manjericão apresenta uma saturação de fotossíntese em altas taxas de radiação, cerca de 1500 μmol m^{-2} s^{-1}. A cultivar de coloração verde foi mais produtiva, além de apresentar os maiores teores de clorofila *a*, *b* e *total*, menores taxa de transpiração foliar, em respostas a densidade de fluxo de fótons fotossinteticamente ativos, resultando em maior eficiência de carboxilação e uso da água.
Palavras-chave: *Ocimum basilicum* L., cultivares, taxa de assimilação líquida.

INTRODUCTION

Basil (*Ocimum basilicum* L.) belongs to the Lamiaceae family and is a shrub-like plant with an annual or perennial cycle, originating in Southeast Asia and Central Africa, with good adaptation to Brazilian climatic conditions, and can be grown all year round. The species is known as *alfavaca*, *alfavaca-cheirosa*, *basílico* ou *manjericão comum*. It has leaves of various colors, with shades of green or red, and can be smooth or wavy, with green leaf basil being the most widely known and most cultivated variety (FILGUEIRA, 2013).

The implantation of the species in Brazil was intensified after the arrival of Italian immigrants, when basil began to be used for various purposes, such as ornamental, medicinal, and aromatic uses due to the presence of substances of interest to the pharmaceutical, cosmetic, and food industries. Thus, the growth in demand for biomass/raw material justifies investments in research on this species, as studies have been restricted to the identification, qualification, and quantification of chemical compounds present in essential oils, while information on agronomic behavior, photosynthetics, antioxidants, and chloroplast pigments are scarce (COUTINHO et al., 2020a).

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Chloroplast pigments are responsible for light absorption and radiant energy transfer. Thus, photosynthetic efficiency depends on the rate of assimilation and interception of solar radiation (TEIXEIRA et al., 2015). Hence, cultivars that show changes in leaf color can provide different responses from the photosynthetic apparatus, which can result in greater efficiency in CO_2 assimilation and consequently present greater availability of photoassimilates for development. In this context, to understand plant metabolism and responses in its development and production it is necessary to know both morphology and physiological variables related to metabolism. Therefore, it is important to quantify characteristics such as photosynthetic pigment levels, net CO_2 assimilation rate, leaf transpiration rate, stomatal conductance, among others (COUTINHO et al., 2020a).

Considering the importance of physiological processes in plants, the present study aimed to evaluate the levels of photosynthetic pigments and morphometric characteristics of two cultivars of green and red basil as a function of collection times and different collection positions in the plant, as well as to assess gas exchange in response to changes in the flux density of photosynthetically active photons.

MATERIAL AND METHODS

The experiment was conducted in a protected environment, at the Protected Crop and Biological Control Station “Professor Dr. Mário César Lopes”, belonging to the “Universidade Estadual do Oeste do Paraná” (Unioeste), Marechal Cândido Rondon *Campus*, from October to December 2016. According to Köppen’s classification, the region's climate is *Cfa* type, subtropical humid mesothermal of dry winter, with well distributed rains throughout the year and hot summers (ALVARES et al., 2013). The average, minimum and maximum values of air temperature and average relative humidity during the basil cultivation cycle are shown in Figure 1.

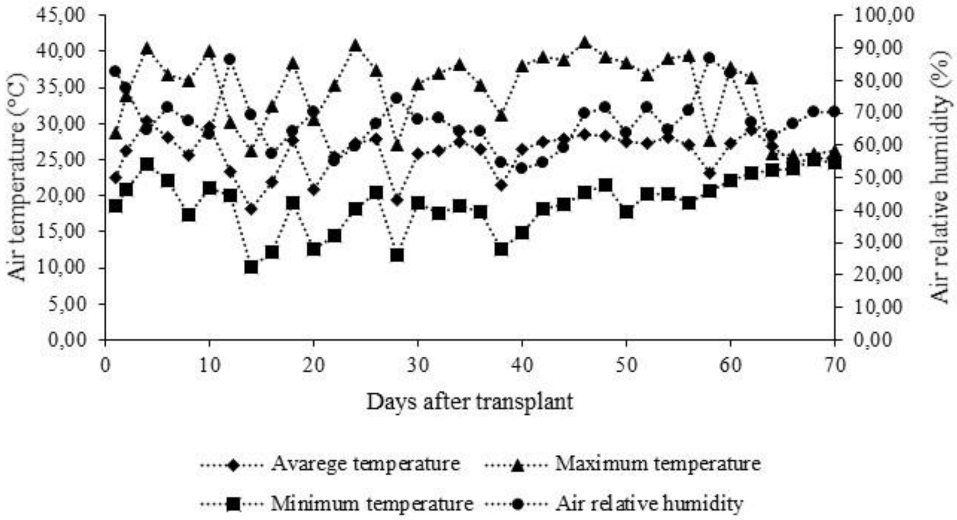

FIGURE 1 - Average, minimum, and maximum values of air temperature and average relative humidity during the basil cultivation cycle.

According to a previous analysis, the soil was identified as Eutroferric RED LATOSOL with a clayey texture presenting the following chemical characteristics in the layer from 0 to 0.20 m — pH(CaCl2) = 6.61; MO = 20.51 g dm^{-3}; P (Mehlich^{-1}) = 235.92 mg dm^{-3}; K (Mehlich^{-1}) = 0.90 cmolc dm^{-3}; Ca^{2+} = 9.78 cmolc dm^{-3}; Mg^{2+} = 3.05 cmolc dm^{-3}; Al^{3+} = 0 cmolc dm^{-3}; SB = 13.73 cmolc dm^{-3}; CTC = 16.34 cmolc dm^{-3}; H + Al = 2.61 cmolc dm^{-3} and V = 84.02%.

The red basil cultivar has leaves with serrated edges and the second cultivar has a smooth green color. Both have a height of 50 cm and a cycle of 60 days in summer and 90 days in winter. The plants were placed with separations of 0.30 x 0.30 m, distributed in four planting lines, containing 16 plants per slot. Fertilization was performed according to soil analysis and recommendations by Ferreira et al. (2016), adding 100 kg ha^{-1} of N, 120 kg ha^{-} of P_2O_5, and 80 kg ha^{-1} of K_2O. The topdressing fertilization was carried out with N in installments at fortnightly intervals. For fertilization, urea, triple superphosphate, and potassium chloride were used as sources of nitrogen, phosphorus, and potassium, respectively.

Irrigation was performed via dripping using flexible tape with a flow of 1.6 L h^{-1} and emitters spaced every 0.30 m. The other cultural treatments were carried out according to the needs of the culture. Plants were collected at 15 days after transplanting (DAT), at 30 days before flowering, and at 45 days after flowering. Leaves from the upper, middle, and lower parts of the plant were selected to determine the levels of chlorophyll a, b, and total (SIMS; GAMON, 2002), carotenoids (NAGATA; YAMASHITA, 1992), and anthocyanins (FRANCIS, 1982). After extracting the pigments, the supernatant obtained was directly read in a spectrophotometer at wavelengths of 663 nm (chlorophyll a), 647 nm (chlorophyll b), 470 nm (carotenoids), and 537 nm (anthocyanins).

To determine the gas exchange, the IRGA equipment (Infra Red Gas Analyzer), model LI-6400XT (Licor Inc. Lincoln, NE) was used. The readings were taken at 32 DAT, between 9:00am and 11:00am, outdoors, performed on the fifth fully expanded leaf of the plant, which had to be physiologically active, without apparent lesions, and fully exposed to direct solar radiation.

For photosynthetically active photon flux density (PAPFD), net CO_2 assimilation rate (A), leaf transpiration (E), stomatal conductance (gs), internal CO_2 concentration (Ci), water use efficiency (WUE=A/E), intrinsic water use efficiency (iWUE=A/gs), and intrinsic carboxylation efficiency (ACi=A/Ci), response curves were calculated and determined by the gradual reduction of luminosity in the 2500 IRGA chamber up to 0 μmol m^{-2} s^{-1}. The CO_2 concentration in the chamber was maintained at 400 μmol mol^{-1} and the leaf temperature was adjusted to 28±3ºC, close to room temperature.

The responses of the curve of A as a function of the PAPFD were adjusted by Equation 1 (PRADO; MORAES, 1997), as follows:

$$A = A_{max}\left[1 - e^{-k(Q-Ic)}\right]$$

Where:

A_{max} = maximum CO_2 assimilation rate, or maximum efficiency in water use,

k = constant and

Ic = light compensation point.

The PAPFD varied below 500 μmol photons m^{-2} s^{-1}, in smaller intervals, making it possible to obtain enough points to calculate the apparent quantum efficiency [Φ (μmol CO_2/μmol photons)], with data adjusted by Equation 2, next:

$$\mathrm{A} = \mathrm{a} + \Phi.\mathrm{Q}$$

Where:

A = maximum CO_2 assimilation rate,

a and Φ = adjustment coefficients and

Q = photon density.

At the intersection of the line, on the X axis, there is the value of the light compensation point. For the other variables, the equations with high R^2 values were adjusted, respecting the physiological behavior. At 68 DAT, the harvest was carried out manually, being sent to the laboratory where the morphometric variables were evaluated, such as leaf area (cm^2), number of leaves per plant, leaf dry biomass (g), and productivity (t ha^{-1}). Leaf area was measured using a bench leaf area meter (Area meter Li-3100C) and dry biomass was obtained after drying in an oven, with forced air circulation at 65ºC, until constant biomass was reached.

The experimental design used was randomized blocks, in a 2 x 3 x 3 factorial scheme, containing 2 treatments consisting of two basil cultivars (*alfavaca basilicão*, red and green) and fifteen replications. The first factor was constituted by the cultivars, the second by the time of collection, and the third by the positions in which the collections were carried out on the plant. Data were submitted to Shapiro-Wilk normality tests ($p \leq 0.05$). Then, the analysis of variance was performed, with the means being compared by the Tukey test ($p \leq 0.05$), using the statistical software SISVAR 5.3 (FERREIRA, 2019).

RESULTS AND DISCUSSION

According to the analysis of variance, there was an interaction between the three factors (cultivars, collection times, and collection position on the plant) for the variables a, b, total, and anthocyanins levels. Higher chlorophyll contents found in cv. Green were already expected, as these pigments are responsible for the predominant green visual color of the vegetables, a characteristic that differs between cultivars (ECHER et al., 2020).

The green basil cultivar, irrespective of the time of collection, presented higher levels of chlorophyll a, b, and total in the leaves (Tables 1 and 2). It was thus demonstrated that these photosynthetic pigments may vary depending on the species, or between genotypes of the same species (ECHER et al., 2020). It is also worth noting that the chlorophyll b content, at 15 DAT, in the upper third of the red basil presented a higher average of 15.47%.

TABLE 1 - Chlorophyll a and b contents of two basil cultivars (green and red), in different parts (thirds) of the plant and collection times.

Cultivars of basil	Season*	Chlorophyll *a* (mg g^{-1})			Chlorophyll *b* (mg g^{-1})		
		Upper third	Middle third	Lower third	Upper third	Middle third	Lower third
Green	15	0.208 aABα	0.223 aAα	0.187 aBα	0.116 aAβ	0.121 bAα	0.088 bAα
	30	0.225 aAα	0.192 bBα	0.158 bCα	0.128 aAα	0.161 aAα	0.160 aAα
	45	0.047 bBα	0.125 cAα	0.038 cBα	0.070 bBα	0.142 abAα	0.057 bBα
Red	15	0.142 aAβ	0.126 aAβ	0.079 aBβ	0.155 aAα	0.143 aAα	0.095 aBα
	30	0.035 bABβ	0.055 bAβ	0.022 bBβ	0.020 bAβ	0.051 bAβ	0.012 bAβ
	45	0.022 bAβ	0.029 bAβ	0.031 bAα	0.020 bAβ	0.044 bAβ	0.037 bAα
		DMS L = 0.027	DMS C = 0.022	CV(%) = 16.46	DMS L= 0.039	DMS C = 0.328	CV(%) = 28.92

*Days after transplanting (DAT). Means followed by the same lowercase letter do not differ statistically from each other for season and, by the same uppercase, for plant parts. Means followed by the same Greek letter do not differ statistically from each other for cultivars according to the Tukey's Test at 5% error probability.

It is important to highlight those chlorophylls play a different role in plant metabolism. Chlorophyll b is an accessory pigment, which together with carotenoids helps in the absorption of light radiation and photoprotection of the antenna complex, maximizing the absorption and transfer of energy to the reaction centers, being known as accessory pigments. Chlorophyll a is the pigment used to carry out the photochemical phase, being the reaction center of the photosystems that allows the transfer and use of light energy in photochemical reactions (TAIZ et al., 2017).

The chlorophyll a and b contents presented different concentrations at the time of collection and part of the studied plants, according to Coutinho et al. (2020a), who observed, in studies with the same plant, proportions of 3:1, respectively. The concentration of chlorophyll, however, can vary, according to the species, location and age of the leaf, and plant vigor (TAIZ et al., 2017).

In general, the middle and upper thirds showed higher content of chlorophyll a, b, and total and anthocyanins. This result corroborates with the hypothesis of basal leaves, under conditions of greater competition for light, being able to act as a drain for photoassimilates, showing that the growth and development of the crop is related not only to the light the plant can absorb, but also to its nutritional stage and temperature, contributing to morphophysiological changes in plants (COUTINHO et al., 2020a; ECHER et al., 2020).

Anthocyanins are water-soluble flavonoids, being one of the most important groups of plant pigments, along with betaines and carotenoids, responsible for the color from red to purple. In this work, the cultivar of red basil showed higher levels of anthocyanins at 45 DAT. The genes that control anthocyanin in basil are unstable, showing about 34% reversion to green plants or green spots (PHIPPEN; SIMON, 2000).

TABLE 2 - Contents of total chlorophyll and anthocyanins of two cultivars of basil (green and red), in different parts (thirds) of the plant and collection times.

Cultivars of basil	Season*	Chlorophyll *a* (mg g^{-1})			Chlorophyll *b* (mg g^{-1})		
		Upper third	Middle third	Lower third	Upper third	Middle third	Lower third
Green	15	0.324 aABα	0.337 aAα	0.285 aBα	0.104 bAβ	0.083 aAβ	0.146 abAβ
	30	0.353 aAα	0.353 aAα	0.300 aBα	0.174 abAβ	0.132 aAβ	0.171 aAβ
	45	0.118 bBα	0.266 bAα	0.095 bBα	0.263 aAβ	0.162 aBβ	0.065 bCβ
Red	15	0.296 aAα	0.270 aAβ	0.172 aBβ	0.314 cAα	0.327 cAα	0.319 bAα
	30	0.055 bABβ	0.106 bAβ	0.034 bBβ	0.544 bAα	0.467 bAα	0.375 bBα
	45	0.043 bAβ	0.073 bAβ	0.068 bAα	0.640 aBα	0.775 aAα	0.564 aBα
		DMS L = 0.051	DMS C = 0.048	CV(%) = 17.24	DMS L = 0.091	DMS C = 0.076	CV (%) = 19.33

*Days after transplanting (DAT). Means followed by the same lowercase letter do not differ statistically from each other for season and, by the same uppercase, for plant parts. Means followed by the same Greek letter do not differ statistically from each other for cultivars according to the Tukey's Test at 5% error probability.

For the carotenoid content, there was a significant interaction between harvest times crossing cultivars and harvest times crossing parts of the plant (Table 3). In the unfolding of the interaction between harvest times crossing cultivars, the highest levels were obtained at 15 DAT for red basil. Carotenoids play important roles in the human body, acting in hormonal, metabolic, and inflammatory regulation, in addition to their role as an antioxidant (COCATE et al., 2014).

Regarding seasons and parts of the plant, at 15 and 30 DAT, the upper and middle thirds, respectively, showed higher levels. It is important to highlight those carotenoids act in plants as photoprotective pigments in photosynthesis, protecting chlorophylls from photo-oxidation, and they also function as membrane stabilizers (TAIZ et al., 2017). The accumulation of chlorophylls and carotenoids in leaves is important for determining the final quality of vegetables (ALVES et al., 2020). The levels of photosynthetic pigments are responsible for the specific coloration of the genotype, in addition to being related to photosynthesis and defense against stress (ECHER et al., 2020), thus providing attributes of visual quality and indicators of the physiological state of the plant.

TABLE 3 - Carotenoid content of two basil cultivars (green and red), in different parts (thirds) of the plant and collection times.

Harvest season	Carotenoids (mg g^{-1})				
	Basil cultivars		Plant parts		
	Green	Red	Upper third	Middle third	Lower third
15 DAT	0.188 bB*	0.322 Aa	0.293 aA	0.254 bA	0.217 cA
30 DAT	0.236 aA	0.223 Ab	0.250 bB	0.288 aA	0.149 cB
45 DAT	0.109 bC	0.224 Ab	0.197 aC	0.154 bB	0.149 bB
CV(%) = 15.62	DMS L = 0.025	DMS C = 0.030	DMS L = 0.030		DMS C = 0.036

*Means followed by the same lowercase letter across rows and by the same uppercase letter across columns do not differ statistically from each other according to Tukey's Test at 5% error probability.

According to Cassetari et al. (2015), the visual quality can be verified in other vegetables, where darker green leaves have higher levels of β-carotene in lettuce, for example, possibly associated with high concentrations of chlorophyll in the leaf. In a study carried out by Abade et al. (2019) with arugula cultivars at different levels of shading, the authors found higher levels of carotenoids in those plants grown in full sun, consequently, with higher levels of chlorophyll and fresh biomass.

For almost all gas exchange indices, there was no interaction between the photosynthetically active photon flux (PAPFD) and the cultivars, thus studying the factors in isolation (Figure 2). When evaluating the PAPFD curves, the light compensation point stabilized close to 1500 µmol m^{-2} s^{-1}, in both cultivars, thus demonstrating that the increments did not cause an increase in the CO_2 assimilation rate (A). However, it is worth noting that the stabilization of A was higher for the green cultivar than for the red cultivar, with values of 27.75 and 23.96 µmol CO_2 m^{-2} s^{-1}, respectively (Figure 2A).

The green cultivar presented higher chlorophyll a, b, and total contents, following the trend of the results for A. It was found, therefore, that the green cultivar responded more efficiently to the more intense light radiation, this superiority being evidenced from 500 µmol of photons m^{-2} s^{-1} and remaining higher up to saturating PAPFD intensities. A study carried out by Echer et al. (2020), with green and purple cabbage grown under no-tillage and conventional planting, found that the first cultivar had higher levels of chlorophyll a, b, and total, in addition to a higher CO_2 assimilation rate (A) when compared to the purple cultivar.

Figure 2b shows values for the green and red cultivars of the apparent quantum efficiency (Φ, angular coefficient of the linear region of the light response curve) of 0.0433 and 0.0366 µmol of CO_2 photons, respectively. In a study carried out with citrus species, a Φ of about 0.038 was observed by Machado et al. (2005). For green cabbage, cultivated under no-tillage and conventional, these values were 0.0255 and 0.0231 µmol of CO_2 photons and in purple, under the same planting system, 0.0218 and 0.0223 (ECHER et al., 2020).

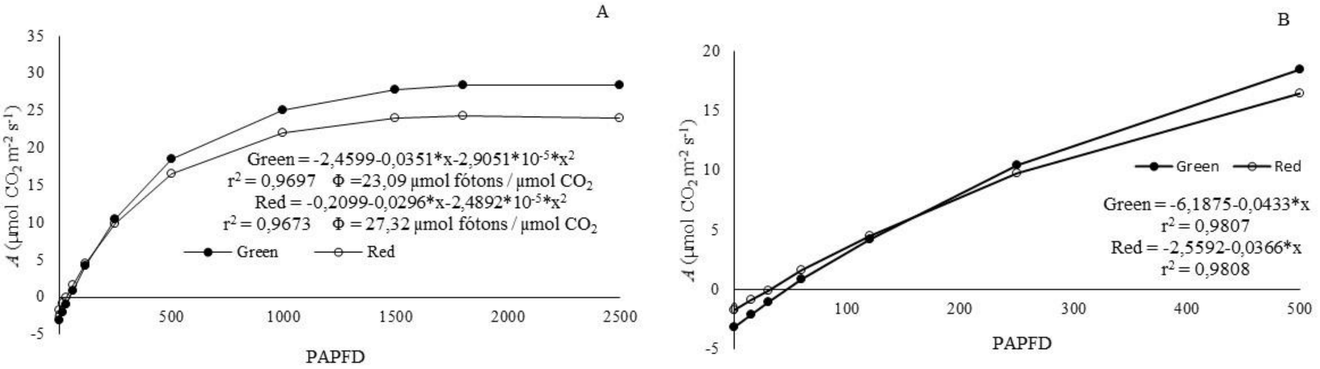

FIGURE 2 - CO_2 assimilation rate (a) and quantum efficiency of CO_2 assimilation rate (b), of two basil cultivars (green and red), as a function of PAPFD.

By the quotient (Figure 3), it can be established that, to fix one mol of CO_2, 23.09 and 27.32 mol of CO_2 are found in this photon, respectively, to cultivate green and red basil. This response to greater photosynthetic efficiency of the red cultivar with green identification due to the higher relation to carboxylation, confirmed by Figure 3F, where the highest levels of chlorophyll a, b, and total were found in the green cultivar. Considering that two cultivars have C3 metabolism, not having a CO_2 concentrator mechanism, these differences may be related to the greater efficiency of ATP and NADPH utilization in the Calvin cycle (ROCHA et al., 2019).

The green cultivar, in general, showed higher photosynthetic capacity, regardless of the time of collection and position in the plant where the sample was collected. The cultivar that presents visual red leaf predominance also had lower apparent quantum efficiency, as a result of the lumic saturation, reached earlier, in relation to the green leaf basil plants, corroborating with Echer et al. (2020), working with green and purple cabbage cultivars.

The basil cultivar with green color was superior for stomatal conductance (gs) and ACi, in relation to the cultivar where the red leaf appearance (Figure 3f) is dominant, both showing, however, an increasing behavior, suggesting the need to increase the flow of CO_2 in the substomatal cavity to maintain the internal concentration of CO_2 (Ci). According to Taiz et al. (2017), lower Ci values stimulate the opening of stomata, with a consequent increase in the CO_2 assimilation rate.

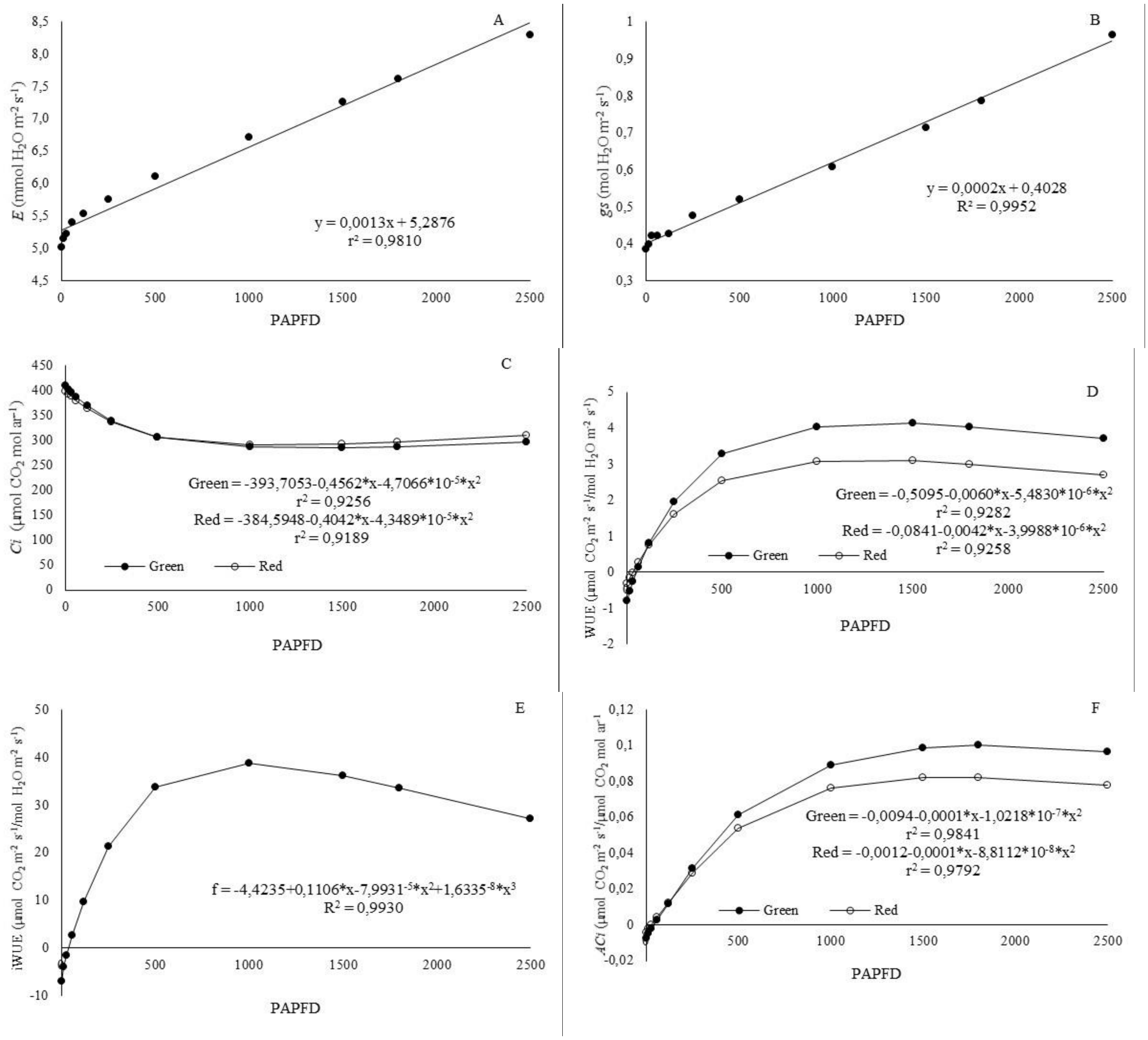

FIGURE 3 - Leaf transpiration- *E* (a), stomatal conductance- *gs* (b), internal CO_2 concentration- *Ci* (c), water use efficiency- WUE (d), intrinsic water use efficiency- iWUE (e) and instantaneous carboxylation efficiency-ACi (f), of two basil cultivars (green and red basilicão alfavaca), as a function of PAPFD.

As seen in Figure 3c, the increase in A caused a decrease in Ci, probably due to the consumption of CO_2, which could also be related to the linear increase in E. The value of Ci can vary according to the carboxylation efficiency, the fixation of CO_2 mediated by the enzyme Rubisco (COUTINHO et al., 2020a; ECHER et al., 2020). This reduction of Ci can cause the reduction of A, due to the decrease in the concentration of CO_2 for the enzyme Rubisco (ribulose-1,5-bisphosphate carboxylase-oxygenase), reducing its efficiency in the uptake and incorporation into the Calvin cycle. This decrease in Ci in basil cultivars occurred in 1000 µmol m^{-2} s^{-1} of PAPFD, yielding 288.37 µmol m^{-2} s^{-1}, increasing as the number of photons increased. Lower values of Ci stimulate stomatal closure, with a consequent decrease in the CO_2 assimilation rate (ROCHA et al., 2019).

The assimilation of CO_2 from the external environment promotes water loss, and this water reduction can restrict the entry of CO_2 (SHIMAZAKI et al., 2007). The decrease in the intrinsic efficiency of water use (iWUE) from 1000 µmol m^{-2} s^{-1} of PAPFD is linked to more intense light radiation, thus resulting in 38.83 µmol CO_2 $mol^{-1.}$ The increase in the instantaneous efficiency of carboxylation (ACi) with PAPFD up to 1800 µmol m^{-2} s^{-1} (Figure 3F), occurred due to the greater amount of CO_2 in the substomatic chamber, thus having more substrate to carry out photosynthesis, that is, all light that the antenna complex received was sent to the electron transport chain to provide energy to the Calvin cycle, having substrate to transform into sugar in the next step (COUTINHO et al., 2020a; ECHER et al., 2020).

The ratio given by the water use efficiency (WUE) reveals the amount of water used, in mmoles, to fix µmols of CO_2. The WUE was higher in the green basil cultivar than in the red one, showing a maximum point of 4.13 and 3.09 µmol CO_2 mmol-1 H_2O, respectively, with a PAPFD of 1500 µmol m^{-2} s^{-1} (Figure 3D). As in the iWUE (Figure 3E), the WUE is linked to the increases seen in the PAPFD. Echer et al. (2020), comparing two cultivars of green and purple cabbage, found that the green cultivar also showed a maximum point in relation to the one that has a visual purple leaf predominance.

Regarding foliar transpiration, it can be observed that the green colored cultivar transpired less (Table 4), thus demonstrating that the red colored cultivar loses more water to the cultivation environment in the form of vapor, regulated by the activity of the stem-cells guards (SHIMAZAKI et al., 2007). When evaluating the behavior of leaf transpiration (E) and stomatal conductance (gs), the two cultivars showed linear behavior, thus demonstrating that there was no limitation in the stomatal opening, corresponding to a transpiration rate that is also linear (Figures 3a and 3b), thus following positively the rise in PAPFD. However, it becomes limited by excess light and photorespiration. According to Taiz et al. (2017), stomatal opening follows photosynthetically active radiation on the leaf surface, where greater stomatal opening is directly related to a higher luminosity rate.

TABLE 4 - Stomatal conductance (gs) and leaf transpiration (E) of two basil cultivars (green and red).

Basil cultivars	g_s (mol H_2O m^{-2} s^{-1})	E (mmol H_2O m^{-2} s^{-1})
Green	0.5814 a*	5.7519 b
Red	0.5381 b	6.6274 a
DMS	0.0198	0.1886
CV(%)	9.35	8.03

*Means followed by the same letter in the same column do not differ statistically from each other according to the Tukey's Test at 5% error probability.

For the characterization of agronomic parameters, there was a statistically significant difference ($p<0.05$) between the cultivars for leaf area, fresh leaf biomass, dry leaf biomass, and yield (Table 5). For the number of leaves, the two cultivars behaved statistically similarly, demonstrating that this characteristic is genetic and inherent to the basil material, regardless of the visual predominance, whether it is green or red on the leaves. Although there are no statistical differences, the two cultivars have a different morphometric format, regardless of extrinsic effects, such as the management adopted, use of mineral fertilizers, among others, which may alter productivity at the end of cultivation (COUTINHO et al., 2020b; ECHER et al., 2020).

TABLE 5 - Number of leaves (NL), leaf area (LA), fresh leaf biomass (FLB), dry leaf biomass (DLB), and productivity (PROD) of two basil cultivars (green and red).

Basil cultivars	NL	LA (cm^2)	FLB (g)	DLB (g)	PROD (t ha^{-1})
Green	160.3 a*	2224.67 a	148.44 a	28.30 a	16.49 a
Red	165.0 a	1606.80 b	108.51 b	23.06 b	12.04 b
CV(%)	20.42	19.55	23.21	25.2	23.27
DMS	33.6058	378.879	30.1705	4.9299	3.3569

*Means followed by the same letter in the same column do not differ statistically from each other according to Tukey's Test at 5% error probability.

The green cultivar presented greater leaf area, fresh leaf biomass, and productivity, consequently also greater dry biomass. This greater biomass production is associated with the photosynthetic carbon assimilation capacity, responsible for about 90% of the plant's dry biomass (TAIZ et al., 2017). The greater leaf area index suggests greater availability of a photosynthetically active surface, thus being in the centers where photosynthesis (production of dry biomass) occurs, responsible for the export of photoassimilates to the dependent organs, where the difference in this characteristic is genetic, which can be influenced due to biotic or abiotic stress conditions (SOUZA et al., 2011).

Regarding the cultivars, it was observed that the green cultivar stood out for all the studied variables, except for the transpiration rate and anthocyanins, thus showing the influence of the genetic factor in relation to the physiological differences between the cultivars. These differences are linked to the concentration of photosynthetic pigments present in these cultivars, mainly chlorophylls, since higher levels resulted in greater photosynthetic potential due to the capturing of energy necessary for the chemical reactions that constitute photosynthesis. However, the differences found show that the red cultivar presented levels close to the green cultivar and can generate greater productivity. Studies related to the physiology and concentrations of pigments in cultures can help improving several cultures, with the aim of producing cultivars that are more productive and of reducing the loss of water for the cultures.

CONCLUSIONS

The highest levels of chlorophyll a, b, and total were found in the green cultivar at 15 and 30 DAT in the upper and middle thirds.

Basil (*Ocimum basilicum* L.) shows a saturation in the net assimilation rate of approximately 1500 µmol m^{-2} s^{-1} of photons.

The green Basil presented higher photosynthetic rates and lower leaf transpiration rates in response to PAPFD, resulting in higher carboxylation efficiency, water use, and productivity.

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