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Influence of meteorological factors on the relative water content of coffee plants in the field

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ABSTRACT

Global climate change is leading to changes in rainfall and temperature parameters. With the lack of water, the coffee plant presents growth and development restrictions. The air temperature also affects the coffee plant. The genetic improvement of coffee can help overcome these difficulties with new cultivars more adapted to the effects of climate change. So, the objective of the present study was to characterize the relative water content (RWC) of Coffea arabica plants of the cultivar Bourbon Vermelho and the variety Semperflorens, respectively sensitive and tolerant to water deficit under field conditions, cultivated in an experimental area in southeastern Brazil. The RWC was evaluated from September to February for three consecutive years in leaves taken from two branches belonging to the apical and basal portions of four plants, positioned facing the cardinal points West and East. The Bourbon Vermelho cultivar and the Semperflorens variety under water deficit had similar RWC responses, around 60%, for both the branches belonging to the apical and basal portions of the plants. It was also demonstrated that RWC was not different between the branches positioned in relation to the East and West cardinal points in both the apical and basal portions for plants of the Bourbon Vermelho cultivar and the Semperflorens variety.

Introduction

On a global scale, the economic and social dynamics can suffer changes. Since the use of soil is predominantly dealt with globally, agriculture involves important economic activities and provides a wide range of ecosystem services, showing considerable sensitivity to climatic variations in its nature (Shiferaw et al., 2014). One can affirm that 'despite all the technological advances over the last decades, agricultural production continues to depend on the weather and climate' (Santos et al., 2018).

Global climatic changes are becoming one of the greatest challenges to the development of diverse sectors of the society, and are of anthropic origin (IPCC, 2018; 2022) or natural causes (Molion, 2005; Silva & Paula, 2009). Independent of their genesis, changes in the parameters of temperature and rainfall have been studied and observed in studies that consider their causes and consequences (Marengo et al., 2009; Porfirio et al., 2018; Kath et al., 2021).

Several studies throughout the world (Assad & Pinto, 2008; Silva et al., 2012; Torres et al., 2022) have pointed out the possible consequences that climate alterations could cause in various agricultural crops. According to the Intergovernmental Panel for Climate Change (IPCC), tropical regions will show a reduction in rainfall, prejudicing agricultural areas. For the coffee crop, a variety of research projects (Jaramillo et al., 2011; Coffee & Climate, 2015; KOH et al., 2020) have indicated potential prejudice for coffee production in the future climatic conditions, indicating the need for studies to adapt the coffee crop (Tavares et al., 2018). An increase in temperature of 1 to 2 ºC could considerably prejudice coffee productivity (Pinto et al., 2007) and consequently the entire productive chain.

Changes in climatic parameters could lead to changes in the localization of areas apt for coffee cultivation, an increase in pests such as Hypothenemus Hampei more commonly known as the "Coffee borer" in various areas throughout the world (Jaramillo et al., 2011), as well as a greater occurrence of typical coffee plant diseases such as rust (Alfonsi et al., 2019) and morphophysiological changes. Considering the forecast of a future scenario of climate changes with negative consequences for coffee production, initiatives for the mitigation and adaptation are required that aim to assuage the future consequences of climate changes. Starting from the presupposition that agriculture has expressive social importance, the taking of preventive initiatives could decrease the prejudice both from the aspect of the agricultural crop production and the social spectrum (George et al., 2008). Thus, strategies that involve communities associated with the coffee production chain are of fundamental importance for food and social safety (Jaramillo et al., 2011).

To determine the best basis for decision making, one must understand, a priori, the physiological and phenological relationships of the coffee plant with such environmental changes. Hence, studies of the relationships existing between climate and coffee crop have great relevance, since they indicate, for example, that changes in water availability considerably decrease the productive performance of the plant, and one can observe symptoms of leaf wilting and other visible signs of water deficit (Matiello, 1991; DaMatta et al., 2003). Amongst the edaphoclimatic factors, water availability and temperature are the most damaging and are increasingly more common, causing changes in the whole basal metabolism of the plants. The responses to water deficit start with a reduction in stomatic conductance and consequently in internal carbon, reducing photosynthesis. This causes a change in the leaf hydric potential (Ψ_{leaf}) or even in the relative water content (RWC), these becoming more and more reduced with the increase of water deficit (Ghannoum, 2009; Xu et al., 2010). According to Anjun et al. (2017) plant growth and development are restricted by a lack of water as from the germination phase up to the stage of the plant in the field. This growth reduction signifies the production of a smaller number of nodes for flower formation, leading to a fall in fruit production (Petek et al., 2008).

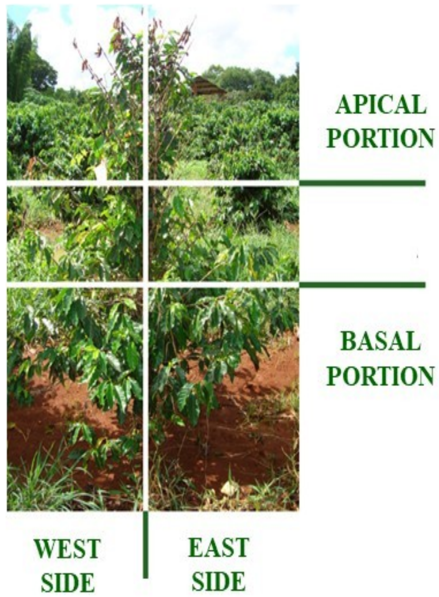
The temperature factor also influences the coffee crop, and each plant development event has an ideal temperature (Silva & Mazzafera, 2008). High temperatures can affect productivity by altering the balance between respiration and photosynthesis (DaMatta & Ramalho, 2006). Generally, a rise in temperature contributes to the occurrence of water deficit in the plants, leading to stomatic closure which can lead to a biochemical limitation of photosynthesis due to low CO_2 availability (Noctor et al., 2014; Ávila et al., 2021). Temperatures above 28 ºC reduce foliar production by coffee plants and photosynthetic activity, and those above 34 ºC favor floral abortion, considerably decreasing productivity (Camargo, 1985; Pilau & Angelocci, 2016). On the other hand, according to Matiello (1991) and Thomaziello et al. (2000) the crop of Coffea arabica shows good performance at mean annual temperatures between 18 and 23 ºC or ideally between 19 and 21 ºC, mean annual rainfall between 1200 and 1800 mm and altitudes between 400 and 1200 m, the altitudes recommended for planting being between 600 m and 1200 m.

The relationship existing between water and the coffee plant is mainly mediated by the action of the climate and its variables such as temperature and rainfall. For these characteristics, water deficit and high temperatures are prejudicial to the growth and development of this crop. The hydric state of the plants can be characterized by different methodologies such as determining the relative water content (RWC), which evaluates the moisture content of vegetable tissues (Andrade et al., 2015; Santos et al., 2015).

The understanding of the relationships existing between hydric availability, temperature and the coffee plant, could provide subsidies for those involved in the productive chain for decision making with a greater chance of success concerning the management of climate risks in farming (Larcher, 2000). One of the solutions most debated concerning the management of climate risks in coffee farming is genetic improvement. The development of cultivars more tolerant to drought events could contribute to a reduction in the impacts of climate changes in the coffee production chain. However, the release of cultivars more tolerant to environmental changes requires subsidies concerning the physiological responses of the genotype of interest in various developmental stages and under different environmental conditions, which could contribute to the development of the new cultivar.

The coffee plants in the field are positioned in rows that provide sunlight on the East side in the morning and on the West side in the afternoon. Bicalho et al. (2005) found that coffee branches exposed to sunlight in the morning showed higher productivity than branches that received it in the afternoon. This response was related to morphological, photosynthetic and water relations differences. The side of the plant that receives sunlight in the afternoon has a higher rate of transpiration, which can affect the metabolism of the plant. Taking these observations into account, it is possible that the relative water content is different between the leaves arranged on the branches facing East and West. Thus, the present study aimed to characterize the relative water content in C. arabica plants in the field with branches positioned in relation to the East and West cardinal points in periods of low rainfall.

Figure 1. Scheme of divisions of C. arabica plants into apical and basal portions, in relation to the east and west faces. The plantations are located in the experimental area of Fazenda Santa Eliza, of the Instituto Agronômico de Campinas. By authors.



Materials and methods

Materials and study site

Coffea arabica plants of the cultivar Bourbon Vermelho and the variety Semperflorens were used. All plants were two and a half years old at the start of the study. These plants belong to the genetic improvement experiment being carried out at the Fazenda Santa Elisa of the Agronomic Institute in the city of Campinas, SP, Brazil, latitude -22.8750816º, longitude 47.0753271º and altitude of 696 meters.

The plants were divided into the apical, basal parts (Figure 1), and two branches marked on each part, one branch opposite the other, positioned, respectively, facing the cardinal points of west and east. Thus, the RWC was obtained from leaves taken from branches positioned facing west and east of the apical and basal parts of four plants of each genotype. Thus, each treatment consisted of four repetitions. Each repetition corresponded to a leaf collected from branches positioned in relation to the East and West points of the apical and basal portions of the plants of each genotype.

Relative water content

The Relative Water Content (RWC) was evaluated according to Slavick (1974). Initially leaves were collected up to the 3rd pair of leaves on each marked branch of each plant in the morning, placed in plastic bags and put in a polystyrene box. Foliar disks were then obtained from these leaves using a cork borer and weighed on an analytical balance to determine their fresh mass. The disks were stored for 24 hours individually in glass jars (20 mL) with the addition of 2 mL distilled water at room temperature, with the objective of reaching maximum turgidity, when the turgid mass of the disks was determined. The glass jars with the leaves but without the water were then placed in a drying chamber at 50 ºC until reaching constant weight, to determine the dry mass. The data obtained were used to calculate the RWC as follows: RWC = 100 (fm-dm)/(tm-dm), Where fm: fresh mass; dm: dry mass and tm: turgid mass.

Weather station

The meteorological data of air temperature and rainfall were collected by an automatic meteorological station installed near the cultivation area. Data were collected in the months of September, October, November, December, January and February during three consecutive periods, namely 2017-2018, 2018-2019 and 2019-2020.

Water balance

For this analysis, weekly values of average air temperature and accumulated precipitation were used. The sequential water balance was estimated according to Thornthwaite & Mather (1955), considering the available soil water capacity (CWA) equal to 75 mm for the locations analyzed. The method adopted for calculating reference evapotranspiration was that of Thornthwaite (1948). The calculation of the sequential water balance was performed in the Excel environment (Rolim et al., 1998).

Statistical analysis

The RWC evaluation was obtained from leaves from four plants of the Bourbon Vermelho cultivar and four of the Semperflorens variety. These leaves were collected from branches positioned in relation to the East and West cardinal points, from the apical and basal portions of the plants, in the months of September, October, November, December, January and February, for three consecutive years, one collection per month, in the early morning.

The CRA data obtained were analysed by an analysis of variance and means were compared by the F test at a significance level of 5% with by using the Genes statistic program (Cruz, 2006). Analysis of variance was applied to verify the difference in RWC between leaves collected from branches positioned between the East and West sides, in the apical and basal portions of the plant for each genotype.

Results

Analysis of the meteorological parameters

The Figure 2 presents climatic data on the day of the RWC evaluation of plants of the Bourbon Vermelho cultivar and the Semperflorens variety in the period between September and January, for three consecutive years.

The analysis of the meteorological parameters during the period from September 2017 to February 2018 showed that the average temperatures were above 20 ºC, while maximum temperature was between 27.2 a 34.9 °C and the minimum temperature in general was below 20 °C (Figure 2A). During this period, it checks for the occurrence of a maximum temperature equal to or above 30°C in the months of September, October, January and February. Furthermore, there was only one episode of rain which was 20 mm in January (Figure 2A). In the period 2018-2019 the highest maximum temperatures were observed between November and January and were all above 30 ºC, being respectively 32.6; 33.7 and 34.4 ºC (Figure 2B) while the average temperatures were mainly between 20.5 to 26.8 °C. The minimum temperatures, in general, were below 20 °C. In this phase, there were two episodes of rainfall, one of 25 and the other of 15 mm in October and January, respectively (Figure 2B). In the period 2019-2020 there were maximum temperature above 30 ºC in September, October, November and December and lower ones in January and February 2020, which were respectively 28.3 and 24.7 °C (Figure 2C). The minimum temperatures in this period ranged from 18 to 20.9 °C while the averages remained between 21.4 to 27.6 °C. There were frequent rainfalls in this period, the largest volume falling in November with about 23 mm.

Analysis of the Hidric Balance

The analysis of the water balance indicates a water deficit in the periods studied, between September and October, in the three years analyzed, and in the 2019-2020 cycle, a more pronounced water deficit was observed in the same period (Figure 3). It is worth mentioning that the condition of water deficit does not mean that there was no rainfall, but that the recorded volumes were insufficient to meet the water needs of the soil, as can be seen in Figure 2.

Analysis of the RWC for the cultivar Bourbon Vermelho

In the period 2017-2018, the RWC of the cultivar Bourbon Vermelho reached its smallest and largest values in the months of September and October, respectively, occurring in a similar way for the apical (Figure 4A) and basal (Figure 4B) portions. The responses for RWC were similar for the other months of this period for both the apical (Figure 4A) and the basal (Figure 4B) portions. Note that during this period one rainfall of about 20 mm occurred (Figure 2A).

In the second period from 2018 to 2019, the cultivar Bourbon Vermelho presented a RWC above 60% for all the months evaluated for both the apical (Figure 4C) and basal (Figure 4D) portions. In the period from 2019-2020, the cultivar Bourbon Vermelho also showed values for the RWC above 60% for all the months evaluated for both the apical (Figure 4E) and basal (Figure 4F) portions, except for January for the branches facing West on the apical portion (Figure 4E).

Analysis of the RWC for the variety Semperflorens

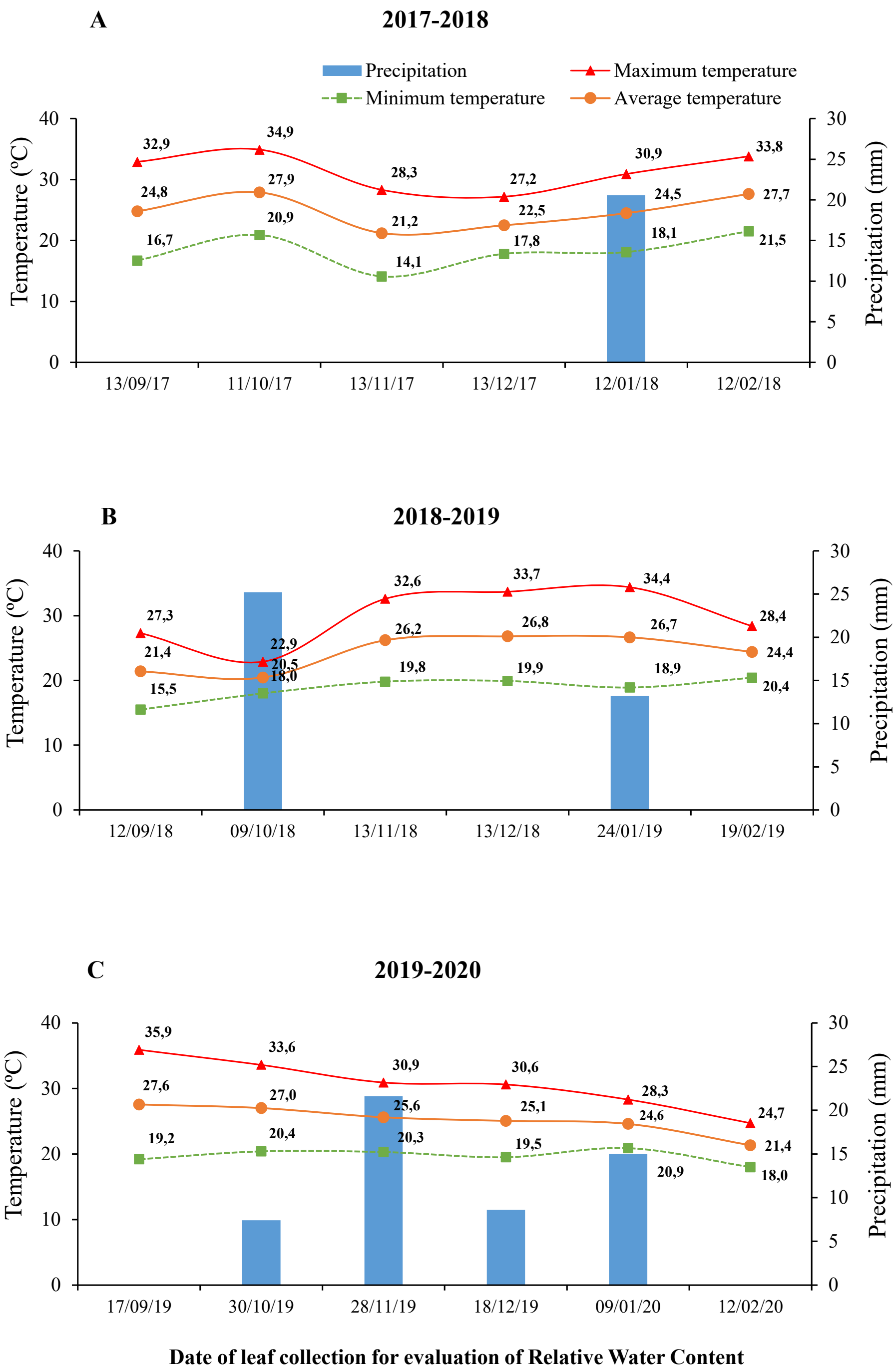
For the variety Semperflorens the values for the RWC in the period 2017-2018 were below 60% in the month of September for both the apical (Figure 5A) and basal (Figure 5B) portions, and in November for the branch facing East on the apical portion (Figure 5A). On the other hand, in this period the RWC was higher in October for both portions (Figure 5A and 5B), followed by the basal portion in December (Figure 5B). In 2018-2019 the variety Semperflorens presented values for RWC above 70% for all the months in both the apical (Figure 5C) and basal (Figure 5D) portions. In the period 2019-2020 this genotype again showed values for the RWC above 70% in both the apical (Figure 5E) and basal (Figure 5F) portions.

The present study showed there was no difference between the values for RWC of the branches positioned facing East and West for each month of evaluation, for either the cultivar Bourbon Vermelho (Figure 4) or variety Semperflorens (Figure 5).

Discussion

In this study, the RWC of C. arabica plants was evaluated from September to January for three consecutive years. The 2017-2018 (Figure 2A) and 2018-2019 (Figure 2B)

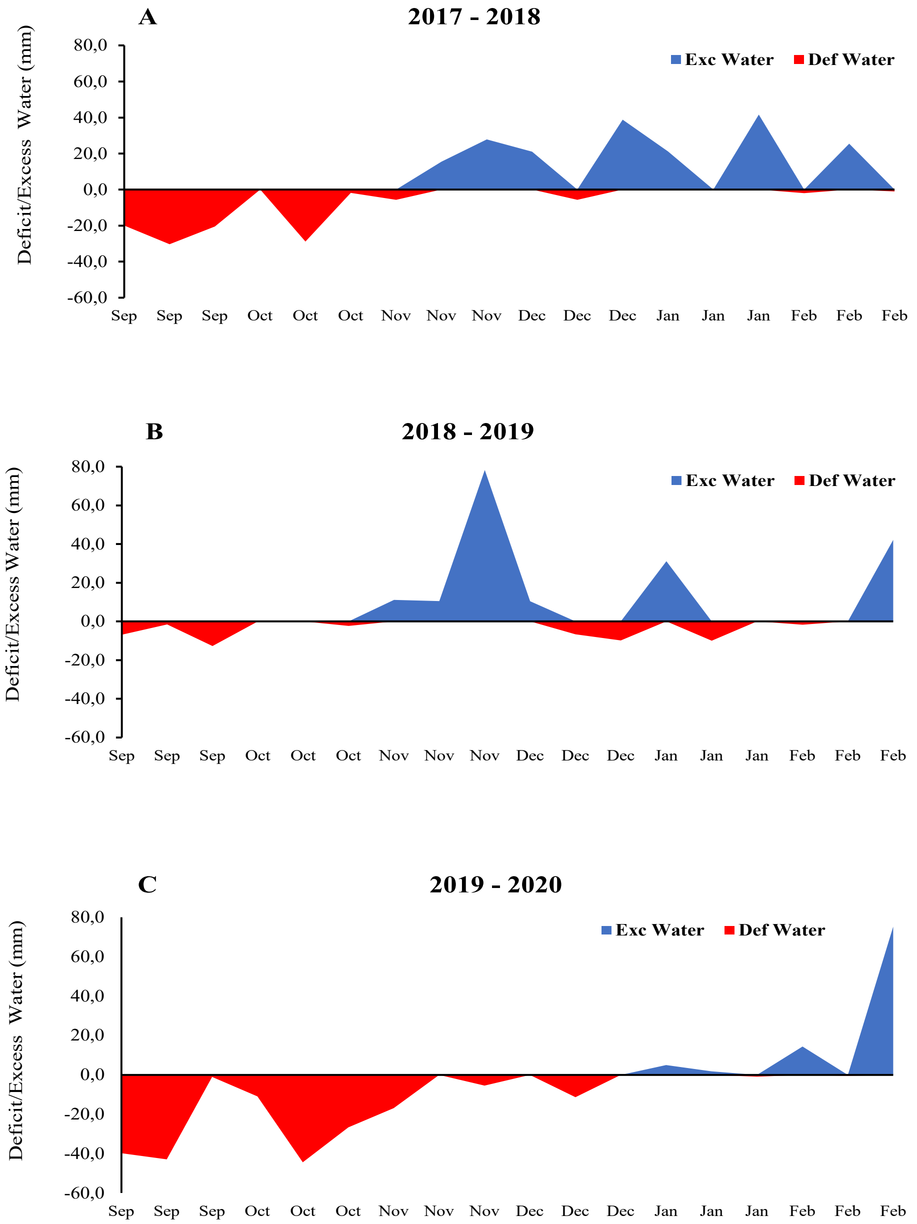
Figure 2. Maximum, minimum and average air temperature and rainfall in the planting area of C. arabica plants of the cultivar Bourbon Vermelho and the variety Semperflorens between the months of September and February, in the years 2017-2018 (A), 2018-2019 (B) and 2019-2020 (C). By authors.



periods showed severe drought due to a lack of precipitation, while the third period of 2019-2020 had four episodes of rain (Figure 2C). The analysis of this scarcity of rain indicates the occurrence of water deficit in the study area, as shown in the water balance of the three periods (Figure 3). In addition, it is noteworthy that in the three periods there were maximum temperatures equal to or above 30 ºC. In nature, in general, severe water scarcity is accompanied by temperatures that harm plant growth and development (Alemu & Dufera, 2017). These characteristics show that the plants of the two studied genotypes of C. arabica were subjected to water deficit in the periods in which they were evaluated for RWC.

In this study plants of the cultivar Bourbon Vermelho and the variety Semperflorens generally showed values for RWC between 60 and 70% throughout the three evaluation periods, except for the month of September 2017 when both genotypes showed values below 60% for the branches facing West and East for both the apical and basal portions (Figures 4A, 4B, 5A and 5B). Drought is a climatic phenome-

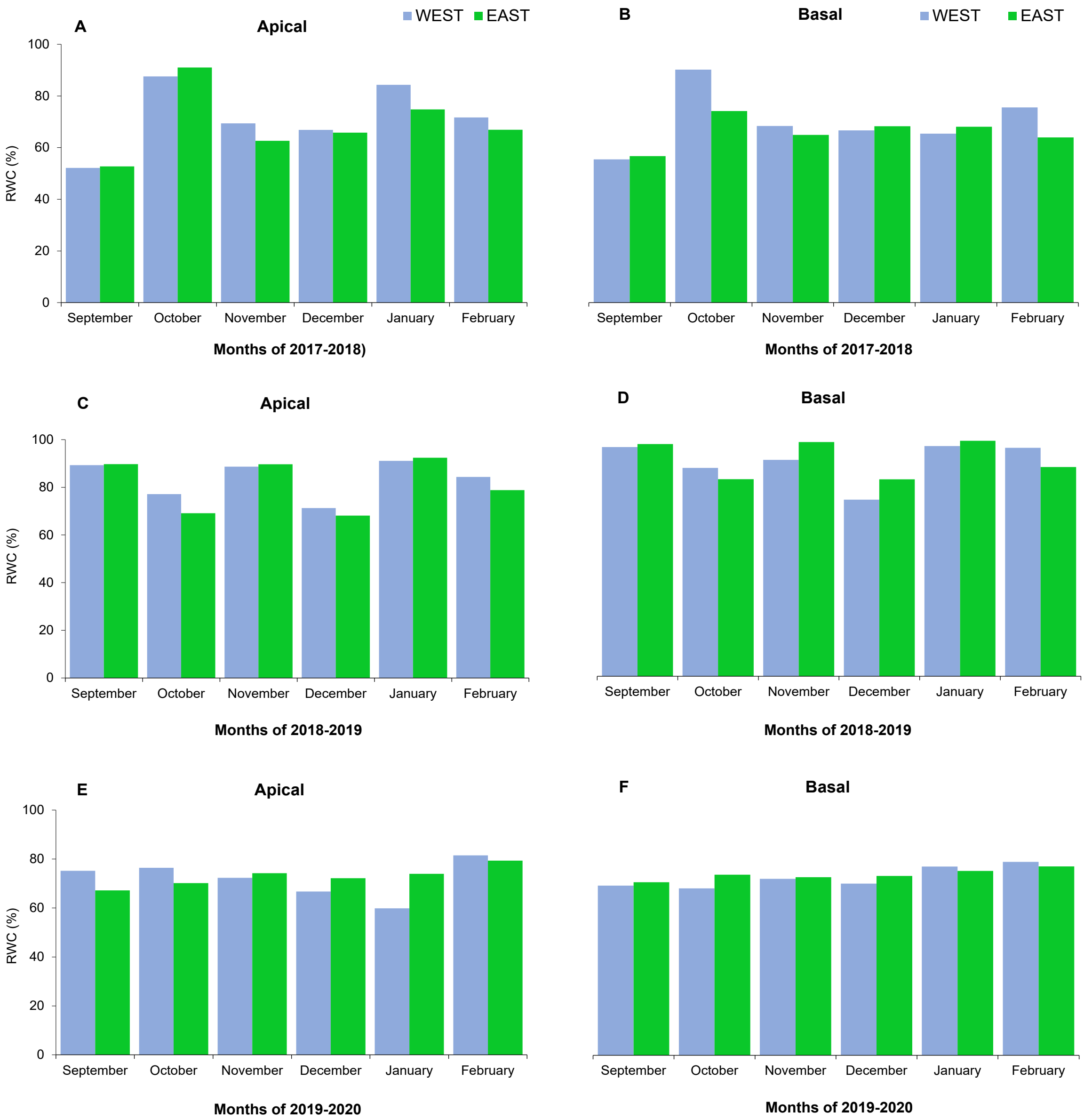
Figure 3. Graphic representation of the water balance extract of the cultivation of C. arabica plants during the months of September, October, November, December, January and February of different periods, being A. 2017-2018, B. 2018-202019 and C. 2019-2020 of the experimental area of Fazenda Santa Elisa, in the Municipality of Campinas in the State of São Paulo, Brazil.



non with a deficiency of rainfall for a long period of time (Buriti & Barbosa, 2018), affecting the hydric relationships of the plants and causing, for example, a reduction in leaf water potential (Kobayashi et al. 2008) and a reduction in the relative water content of the tissues (Santos & Carlesso, 1998).

However, although the plants of both genotypes were under hidric deficit and temperatures above 30 °C in the months of September and October of the studied periods, they were generally capable maintaining the RWC rate above 60%. Barr (1962) discuss that RWC values of about 98% indicate turgidity of the vegetable tissue whereas those between 60 and 70% are a sign of a reduction in moisture content in the plant. Thus, this RWC rate of around 60% indicates that the plants of both genotypes lost moisture, but they were still able to preserve an adequate amount of water in their tissues even in conditions of water deficit. However, although plants of both genotypes preserved moisture in their tissues it is possible that these conditions have impaired their metabolism. This aspect is reinforced by the observation that the lack of rain associated with temperatures above 28 °C tend to harm the different phenological stages of the coffee plant (Thomaziello, 2000; Ávila et al., 2011, Noctor et al., 2014). On the other hand, Silva et al. (2022) found that plants in the field of genotypes E237, Catuaí Vermelho and IAPAR 59 under water deficit had RWC lower than 50% in two consecutive years, with 2019 being characterized by greater scarcity of rain-

Figure 4. Relative Water Content (RWC) obtained from leaves belonging to branches arranged in relation to the West and East sides of the apical and basal portions of C. arabica plants of the cultivar Bourbon Vermelho, located in an experimental area of the Instituto Agronômico de Campinas, in consecutive years. There was no statistical difference between the treatments analyzed by the analysis of variance at the 5% level. By authors.

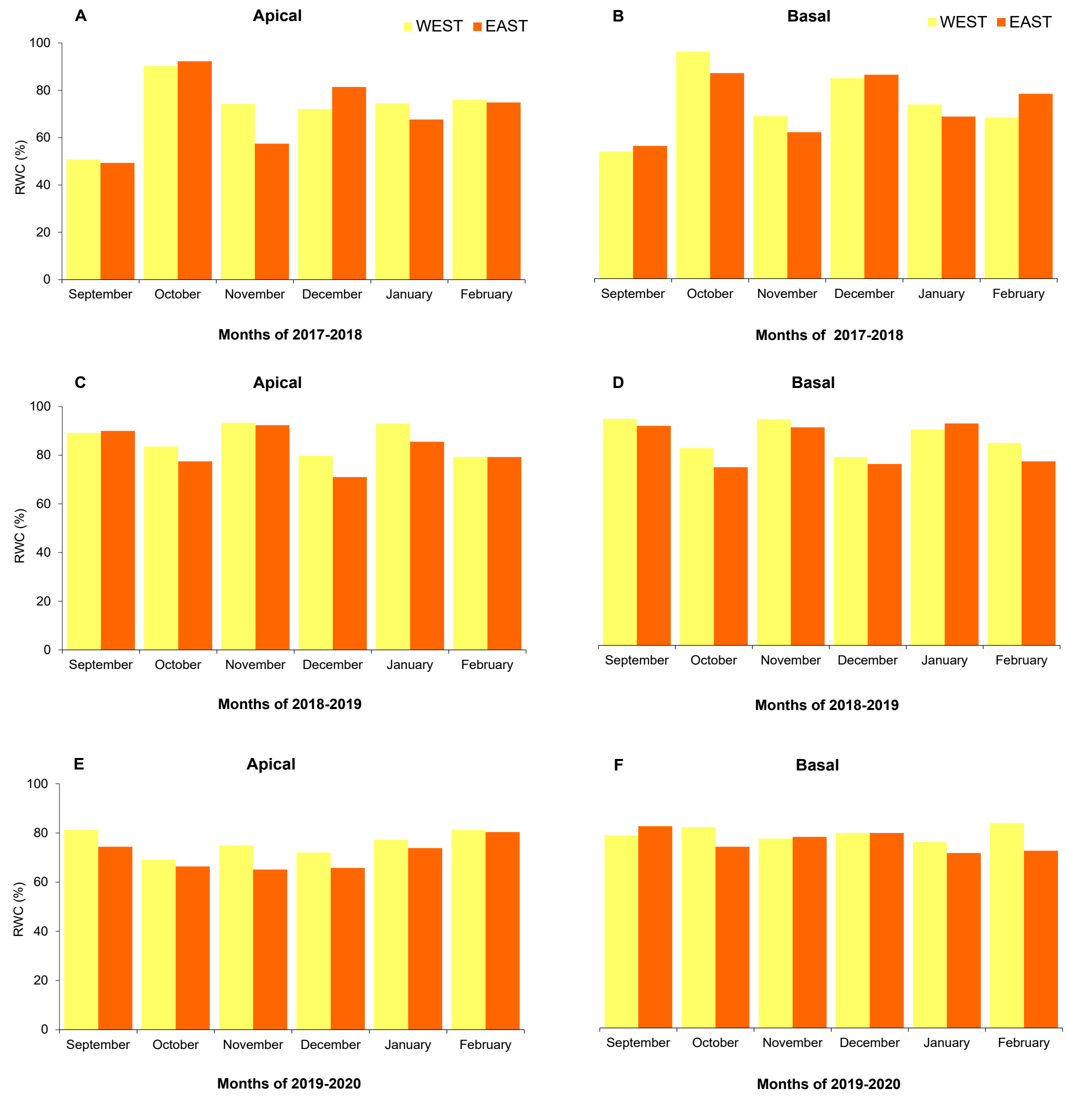


fall and higher temperatures than in 2020. In addition, these plants had reduced productivity compared to irrigated treatments. Thus, the plants in the present study preserved a higher moisture content (60 %) in their tissues than those evaluated by Silva et al. (2022) (50 %) although all of them have gone through periods of scarcity of rain and high temperatures. Almeida et al. (2018) also evaluated the RWC of 23 genotypes of C. arabica in the field during the dry season. According to these authors, when the maximum temperature was equal to or above 30 °C, only plants of the Mundo Novo cultivar, of the Semperflorens variety and of six genotypes in the selection phase had RWC equal to or above 60% while the others had moisture content below 60% and still showed symptoms of leaf wilt.

Plants of C. arabica in the field are exposed to climatic factors that may or may not impair morphophysiological responses (Damatta & Ramalho, 2006). Batista et al. (2010) classified plants of the cultivars Bourbon Amarelo IAC 6 and Catimor UFV 5390 with drought tolerance capacity due to their higher stomatal density in relation to the other 13 evaluated genotypes. In addition, genotypes of C. arabica have an efficient stomatal apparatus that controls the transpiration of plants subjected to drought, which allows them to preserve more moisture in their tissues (DaMatta, 2004; Sena et al., 2007).

On observing the results for each genotype during the three periods of evaluation note that the cultivar Bourbon Vermelho generally showed lower RWC values for the

Figure 5. Relative Water Content (RWC) obtained from leaves belonging to branches arranged in relation to the West and East sides of the apical and basal portions of *C. arabica* plants of the Semperflorens variety, located in the experimental area of the Instituto Agronômico de Campinas, in consecutive year periods. There was no statistical difference between the treatments analyzed by the analysis of variance at the 5% level. By authors.



2017-2018 period as compared to the other periods (Figure 4), and this response was also verified for the variety Semperflorens (Figure 5). This response is in agreement with the cultivar Bourbon Vermelho which is known to be susceptible to drought (Carvalho, 2008) but is not expected for the variety Semperflorens which is tolerant to lack of water (Antunes, 1960). On the other hand, most evaluations of the present study indicate that the response for the RWC was equal to or above 60% for the two genotypes independent of their aptness to drought tolerance, the cultivar Bourbon Vermelho plants being susceptible to drought whereas plants of the variety Semperflorens show drought tolerance. Perhaps, this response pattern could be related to the more lack of rainfall that occurred in 2017-2018 as compared to the other periods, which showed a greater frequency of rainfalls (Figure 2). However, note also that the variety Semperflorens generally presented numerically higher values for the RWC than the cultivar Bourbon Vermelho (Figure 4). These observations could indicate that the variety Semperflorens used some strategy that favored the preservation of a greater moisture content in its tissues, which could be related to the fact that this genotype is known for its tolerance of a lack of water (Antunes, 1960) whereas the cultivar Bourbon Vermelho is susceptible to drought (Carvalho, 2008).

So these results indicated that the two genotypes studied preserved similar moisture content in their tissues even under conditions of low hydric availability in the environment. These observations suggest that the plants of the two genotypes studied used some type of strategy to overcome the lack of water in the soil since these had an average RWC of 60 %. Plants submitted to environmental stress factors develop alternative mechanisms to overcome the action of these factors, which are generally morphological and endogenous changes that allow for some degree of tolerance to the factors (Levitt, 1980; Deuner et al., 2011; Sett, 2017; Fàbregas & Fernie, 2019; Fuentealba-Sandoval et al., 2020). DaMatta et al. (2003) also stated that to maintain a positive hydric status, plants can develop deep roots to increase water capture from the soil.

The results obtained in this study can also bring contributions to the genetic improvement of the coffee tree, by showing that plants of the Bourbon Vermelho cultivar and the Semperflorens variety were able to preserve moisture in their tissues when under conditions of water deficit accompanied by temperatures above 30º C, desirable characteristic in the selection of plants tolerant to lack of water. With extreme drought events being recorded around the world with increasing intensity and frequency, information related to genotypes resistant to water deficit can support genetic improvement that seeks the development of drought-resistant cultivars. Drought-resistant cultivars are one of the strategies for adapting to climate change in coffee production. However, further studies need to be done taking into account other environmental variables, as well as other genotypes and the potential for resistance to water deficit.

Another aspect from this study is that the results also indicated no difference between the monthly RWC values for leaves facing West and East, both for the cultivar Bourbon Vermelho and the variety Semperflorens. Studies have indicated that the position of plants as related to the cardinal points can affect the physiological events of the plants (Rodrigues & Leite, 1999). Although this aspect has been little studied so far, results have indicated that the side of a coffee plant that receives sun in the morning shows greater productivity than the side exposed to the afternoon sun (Bicalho et al., 2005). In general, the sun rises in the East and sets in the West, so the side of a plant facing East is exposed to less sunlight in the morning when the temperature and the vapor deficit are relatively smaller and do not, therefore prejudice the metabolic events of the plant, whereas in the afternoon the side facing West receives sunlight of high intensity which accompanies these events and prejudices the physiological events of the plants (Santinato, 2020). However, although the sides facing West and East influence the productivity of the coffee branches (Bicalho et al., 2005), the results of the present study indicated they did not alter the RWC values of the leaves attached to them. Considering the results obtained in this study and those of Bicalho et al (2005) who found a difference in productivity between branches of coffee trees exposed to the East and West sides, it is possible that this difference is related to other factors such as the efficiency of the photosynthetic apparatus on one side compared to the other. Therefore, it would be important to compare the photosynthetic responses of the leaves of the branches positioned in relation to the east and west cardinal points of plants under water deficit condition.

Conclusions

Plants of C. arabica of the cultivar Bourbon Vermelho which is sensitive to lack of water and the variety Semperflorens which is tolerant to lack of water under water deficit generally maintained relative water content responses in the foliar tissues at levels above 60%, and this response was verified for the leaves of the apical and basal portions of the plants.

The RWC rate was not different between branches positioned in relation to the East and West cardinal points, both in the apical and in the basal portions, for the cultivar Bourbon Vermelho and for the variety Semperflrens.

The evaluated materials, as they are tolerant to water deficit, can be used in drier regions, but mainly as an important source in genetic improvement programs, aiming at obtaining commercial varieties tolerant to drought, as a mitigation option in coping with changes/variabilities weather.

Author contributions

C. N. CAMPOS and G. A. L. TORRES conception of article, acquisition and analysis of data and writing of the article. A. R. LOPES acquisition and analysis of data. A. P. PANTANO and J A. S. de ALMEIDA conception of article, acquisition and analysis of data and review of the article.

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Influência de fatores meteorológicos no conteúdo relativo de água do cafeeiro no campo

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RESUMO

As mudanças climáticas globais estão levando à mudanças nos parâmetros de precipitação e temperatura. Com a falta de água, o cafeeiro apresenta restrições de crescimento e desenvolvimento. A temperatura do ar também afeta o cafeeiro. O melhoramento genético do café pode ajudar a superar essas dificuldades com novas cultivares mais adaptadas aos efeitos das mudanças climáticas. Assim, o objetivo do presente trabalho foi caracterizar o teor relativo de água (CRA) de plantas de Coffea arabica da cultivar Bourbon Vermelho e da variedade Semperflorens, respectivamente sensíveis e tolerantes à deficiência hídrica em condições de campo, cultivadas em uma área experimental no sudeste Brasil. O CRA foi avaliado de setembro a fevereiro por três anos consecutivos em folhas retiradas de dois ramos pertencentes às porções apical e basal de quatro plantas, posicionadas voltadas para os pontos cardeais Oeste e Leste. A cultivar Bourbon Vermelho e a variedade Semperflorens sob deficiência hídrica apresentaram respostas de CRA semelhantes, em torno de 60%, para ambos os ramos pertencentes às porções apical e basal das plantas. Também foi demonstrado que o CRA não foi diferente entre os ramos posicionados em relação aos pontos cardeais Leste e Oeste tanto na porção apical quanto na base para plantas da cultivar Bourbon Vermelho e da variedade Semperflorens.

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