Scientia Agraria Paranaensis

Scientia Agraria Paranaensis – Sci. Agrar. Parana.
ISSN: 1983-1471 – Online
DOI: https://doi.org/10.18188/sap.v21i2.29373

SELECTION OF LARGE BEANS COFFEE GENOTYPES FOR CERCOSPORIOSIS AND COFFEE LEAF RUST RESISTANCE

Ali Romero Gurdian[1], Cássio Pereira Honda Filho[1*], Dyanna Rangel Pereira[2], Harianna Paula Alves de Azevedo[1], Samuel Pereira de Carvalho[1]

SAP 29373 Received: 20/02/2021 Accepted: 29/05/2022
Sci. Agrar. Parana., Marechal Cândido Rondon, v. 21, n. 2, apr./jun., p. 118-125, 2022

ABSTRACT - The development of disease resistant coffee cultivars is of paramount importance to increase grain yield and decrease production costs. The lack of information on how the new cultivars resist the attack of diseases and pests is a limiting factor in the selection of the best cultivars. Thus, the objective of the present work was to select superior genotypes of the Big Coffee VL group for resistance to *Hemileia vastatrix* and *Cercospora coffeicola*. The experiment consisted of 18 progenies pre-selected from a group of 100 genetic materials, for the trait of productivity. The experiment was carried out in a randomized block design, with six blocks and one plant per experimental plot, totaling 108 individuals. The selected coffee plants were evaluated for 10 months for injuries caused by coffee leaf rust and brown eye spot using commonly used diagrammatic scales. During the evaluated months, the genotypes G10, P32 and M22 were more tolerant to rust and brown eye spot. Thus, they are good candidates for genetic improvement programs with the objective of producing larger grains and adding resistance to the main diseases of arabica coffee.
Keywords: Plant Breeding, sum of ranks, genetic variability, *Hemileia vastatrix*, *Cercospora coffeicola*.

SELEÇÃO DE GENÓTIPOS CAFEEIROS DE GRÃOS GRAÚDOS PARA RESISTÊNCIA À FERRUGEM-DO-CAFEEIRO E CERCOSPORIOSE

RESUMO - O desenvolvimento de cultivares de café resistentes a doenças é de suma importância para aumentar a produtividade de grãos e diminuir os custos de produção. A falta de informações sobre como as novas cultivares resistem ao ataque de doenças e pragas é um fator limitante na seleção das melhores cultivares. Assim, o objetivo do presente trabalho foi selecionar genótipos superiores do grupo Big Coffee VL para resistência a *Hemileia vastatrix* e *Cercospora coffeicola*. O experimento foi constituído por 18 progenies pré-selecionadas de um grupo de 100 materiais genéticos, para o caractere de produtividade. O experimento foi conduzido em delineamento de blocos ao acaso, com seis blocos e uma planta por parcela experimental, totalizando 108 indivíduos. Os cafeeiros selecionados foram avaliados por 10 meses para injúrias causadas pela ferrugem-do-cafeeiro e cercosporiose por meio de escalas diagramáticas comumente utilizadas. Após as avaliações, os genótipos foram submetidos a um Índice de Seleção para melhor discriminação dos melhores materiais genéticos. Durante os meses avaliados, os genótipos G10, P32 e M22 se mostraram mais tolerantes à ferrugem e cercosporiose. Com isso, são bons candidatos para programas de melhoramento genético com o objetivo de produzir grãos maiores e, agregar resistência as principais doenças do cafeeiro arábica.
Palavras-chave: Melhoramento genético, soma de pontos, variabilidade genética, *Hemileia vastatrix*, *Cercospora coffeicola*.

INTRODUCTION

The development of disease resistant coffee cultivars is of paramount importance to increase grain yield and decrease production costs. The lack of information on how the new cultivars resist the attack of diseases and pests is a limiting factor in the selection of the best cultivars (CARVALHO et al., 2010). In breeding programs, it is desirable that the new cultivars under development are superior to their predecessors, which show, in addition to resistance to pests and diseases, improvements in other agronomic characteristics (RAMALHO et al., 2012), in order to reconcile cultivars with high productivity, resistance to coffee plants rust and lower incident of cercosporiose (CARVALHO et al., 2017).

Coffee leaf rust is caused by the fungus *Hemileia vastatrix*, considered the main disease of coffee plants in the world (GICHURU et al., 2021). This disease, which had its first record in Brazil in 1970, is now present in all coffee producing regions of the country, causing losses ranging from 35 to 50% of the final production. (AVELINO et al. 2015).

The optimal conditions for its development are temperatures between 21 and 23ºC and leaf blade wetting. With the presence of the fungus, premature defoliation occurs, resulting in a decrease in leaf area and consequent reduction in photosynthetic capacity. Crops with high outstanding loads are more likely to have an increase in disease progress, and it's necessary to pay attention to control it in high yield years. (CARVALHO; CHALFOUN; CUNHA, 2010).

Chemical control is one of the alternatives and satisfactory results are achieved with protective fungicides. However, the use of resistant cultivars obtained by conventional plant breeding is the best way to prevent

[1]Universidade Federal de Lavras (UFLA), Lavras, MG, Brasil. E-mail: *cassiop.hondafv@gmail.com. *Corresponding author.
[2]Empresa de Pesquisa Agropecuária de Minas Gerais (EPAMIG), Lavras, MG, Brasil.

disease progression in the field (ROCHA et al., 2013; VIANA et al., 2018). In this context, the development of rust resistant cultivars plays an important role, both in reducing production costs and in reducing the risks of contamination of the environment and rural workers with the inappropriate use of pesticides in chemical control (PETEK et al., 2008). According to Herrera et al. (2009), resistance is associated with the advance of the epidemic and the balance of defoliation in the field, so that partially resistant individuals show a slow evolution of the epidemic and less defoliation.

In recent years, another disease that has gained importance is Cercosporiosis, caused by the fungus *Cercospora coffeicola* Berk & Cook (AZEVEDO DE PAULA et al., 2016). Cercosporiosis is found in most coffee producing regions in Brazil, causing damage to leaves and fruits (LIMA et al., 2012). The disease symptoms on the leaves are circular in shape, with a dark brown spot surrounded by a pale-yellow halo. The presence of the fungus stimulates the plant to produce ethylene which can cause intense defoliation, generating quantitative losses, reducing crop yield and productivity, even with less severity (CUSTÓDIO et al., 2011).

According to Botelho et al. (2010), there is genetic variability for resistance to *Cercospora coffeicola* in some coffee genotypes and genetic gains can be obtained through selection. Pozza et al. (2001) states that cercorporiosis is the coffee plants disease most likely to be controlled with cultural practices and, in some cases, avoid the use of chemical control. Among the cultivation practices recommended for the management of the disease are: avoiding excessive substrate moisture, excessive sunlight and, mainly, balanced fertilization of the substrate, as cercosporiose is greatly influenced by the nutritional conditions of the plant (Fernandes et al., 1991). This reinforces the need to obtain resistant coffee genotypes for *Cercospora coffee*.

One of the objectives of improving coffee is to increase the size of the grain (GUEDES et al., 2013), since obtaining high-sieve grains allows for greater added value to the product, especially for the production of special grains. cafes. According to Ferreira et al. (2013) it is desirable that the beans used in espresso coffee machines have a high sieve. Thus, it is important that breeding programs use productive genotypes and large grains to meet this need.

In 1989, in a coffee plantation of the cultivar Acaiá (*C. arabica*) in the Midwest of Minas Gerais, in the municipality of Capitólio, a different coffee plant was found, possibly by mutation; this coffee plant presented larger leaves and grains than those of the conventional coffee plants and was called “Big Coffee VL”. Subsequently, its progenies were cultivated in Piumhí, Minas Gerais. In 2012, seeds collected from these plants were used to set up an experiment at the Federal University of Lavras (UFLA). Thus, the objective of the present work was to select superior genotypes from the Big Coffee VL group for resistance to *Hemileia vastatrix* and *Cercospora coffeicola*.

MATERIAL AND METHODS

The experiment was carried out in the Coffee Sector, at the Department of Agriculture of the Federal University of Lavras (UFLA), Lavras, Minas Gerais. The experiment was installed in 2012, with 100 progenies of Big Coffee VL coffee plants from Piumhí, MG, with 32 progenies classified as “Large” (G5, G6..., G36), 36 progenies classified as “Medium” (M1, M2,..., M36) and 32 progenies classified as “Small” (P5, P6,..., P36). This classification was established according to grain size. The planting was carried out in February of that year, with a spacing of 3.5 x 0.9 m, applying the cultural practices recommended for the coffee plant. The design used was the 10x10 lattice, with 23 replications, with a total of 2300 plots, each plot consisting of one plant. However, for the present work, only the 18 most productive progenies were used, according to the work carried out by Silva et al. (2016), arranged in six randomized blocks, and one plant per experimental plot, totaling 108 individuals.

In August 2018, as a result of a depletion, a drastic pruning was carried out in the experiment, cutting the main stem of each plant 40 cm from the soil to promote the renewal of the crop through the recepa. After pruning, the plants received the appropriate cultural treatments such as fertilization and weed control between the rows so that the plants were subject to normal growing conditions. The severity of *Hemileia vastatrix* and *Cercospora coffeicola* was then evaluated in coffee shoots after harvesting, in order to identify the genotypes least affected by these diseases. These assessments began in April 2019. For rust severity, coffee shoots were evaluated as a whole, without any reference to the cardinal points, or sun exposure face, as usual, due to the homogeneity of the canopy. Analogous to the evaluation of rust, the severity of cercosporiosis was measured by sampling 20 leaves, using the diagrammatic scale proposed by Custódio et al. (2011).

The evaluations were carried out in the months of April, May, July, August, September, October and November 2019, returning in the months of February, March and April 2020. During the evaluation period of the experiment, no fungicide application was made in the experimental area.

After collecting and compiling the data, they were submitted to analysis of variance and when significant differences were found at 1 and 5%, the data were grouped using the Scott- Knott test, at a 5% error probability, for the diseases individually and also for diseases in different environments (assessment months). At the end, the genotypes were arranged among themselves using the Selection Index proposed by Mulamba and Mock (1978).

RESULTS AND DISCUSSION

The results of the data submitted to analysis of variance are presented in Table 1. Significance is observed by the F Test at the level of 1% in the evaluations of rust for the effects of genotypes, and for the effect of months. As for the cercosporiose evaluations, it is observed that the effects were significant, at a 5% error probability, for the genotypes, and at the 1% level for the evaluations or months. Interactions between genotypes and assessments or months were not significant for both diseases. The coefficients of variation indicated good experimental precision, with CVa of 27.30% and CVb 15.14% for rust, and CVa 28.13% and CVb 17.97% for cercosporiose. Similar results regarding the coefficient of variation were found by Carvalho et al. (2017) when they analyzed the behavior of different cultivars to diseases caused by the pathogens *Hemileia vastatrix* and *Cercospora coffee*.

TABLE 1 - Summary of the analysis of variance of severity for the evaluations of coffee-leaf-rust and cercosporiosis, carried out in 18 genotypes of coffee called "Big Coffee", in 10 months of evaluations.

PV	GL	Coffee-leaf-Rust [1]	Cercosporiosis [1]
		squares medium	
Replicates	5	0.4019 ns	2.7830 ns
Genotypes (G)	17	3.5759**	2.4343*
error a	85	0.8102	0.9841
Rating (A)	9	5.6009**	14.9021**
G x A	153	0.4863 ns	0.5901 ns
error b	810	0.2490	0.4015
Total	1079		
Average		3.2964	3.5264
CVa (%)		27.30	28.13
CVb (%)		15.14	17.97

GL = degree of freedom, ns = not significant at 5% probability by the F test. *significant at 5% probability of error by the F test. **significant at 1% probability of error by the F test. [1] Transformed data to $\sqrt{x+1}$.

By means of the Scott- Knott grouping test, at 5% error probability, genotypes P5, P12, P14, P32, M20, M22, G9, G10 and G12 presented statistically equal mean severity scores for rust. and smaller than the others. Followed by genotypes P23, P36, M4, M5, M24, G16, G17 and G31. The same test grouped genotypes P14, P32, P36, M4, M22, G9, G10 G12, G17 and G31 with statistically lower averages of severity scores for cercosporiosis. And genotypes P5, P12, P23, M5, M11, M20, M24, and G16 had the highest scores (Table 2). Lower scores indicate a lower incidence of the disease. Considering that the cultivars of the Acaiá group, from which these studied genotypes originated, are rustic cultivars and susceptible to both rust and cercosporiosis (CONSÓRCIO PESQUISA CAFÉ, 2011), among these genotypes, those that are more tolerant to both are sought. the diseases.

TABLE 2 - Averages of severity scores for coffee-leaf-rust and cercosporiose of the evaluated genotypes.

Coffee Genotypes	Coffee-leaf-rust	Cercosporiose
P5	5.10c*	7.73a
P12	4.30c	7.44a
P14	5.27c	5.85b
P23	6.41b	8.35a
P32	4.61c	5.40b
P36	6.36b	7.25b
M4	7.33b	5.80b
M5	5.63b	9.12a
M11	9.50a	7.26a
M20	4.72c	8.52a
M22	4.14c	6.59b
M24	6.19b	7.84a
G9	5.60c	6.24b
G10	3.97c	5.39b
G12	5.18c	6.26b
G16	6.56b	8.93a
G17	5.97b	6.42b
G31	5.72b	6.00b

*Averages followed by the same letters constitute a statistically homogeneous group, according to the Scott- Knott test (p<0.05).

Low and medium disease incidences for genotype selection is interesting, as it may indicate horizontal or non-specific resistance, when there is no disease incidence, there is probably vertical or specific resistance, which is easier to break down into smaller amounts. time (BOTELHO et al., 2010).

The evaluations of April (2019) and May presented the lowest averages in the severity grades for rust, by the Scott - Knott test at the level of 5% of probability, followed by the evaluations of August and September. July 2019, February and March 2020 showed the highest averages for rust. For cercosporiosis, the evaluation of April (2019) had the lowest average score, followed by the evaluations of May, October and April (2020). The months with the highest averages were August 2019 and March 2020 (Table 3). Fungal diseases are highly dependent on climatic conditions for plant infection and development and can cause large epidemics when favorable (AVELINO et al. 2015).

TABLE 3 - Averages of severity scores for coffee plant rust and cercosporiosis for the 10 months evaluated.

Sevetiry evaluations	Coffee leaf rust	Cercosporiosis
Year 2019		
April	4.31d*	3.97d
May	3.71d	4.87c
July	7.40a	8.30b
August	5.06c	9.89a
September	4.79c	8.45b
October	5.68b	4.85c
November	5.94b	8.49b
Year 2020		
February	6.40a	7.44b
March	6.66a	8.81a
April	7.01a	5.13c

*Averages followed by the same letters constitute a statistically homogeneous group, according to the Scott- Knott test (p<0.05).

Analyzing the behavior of these diseases over time is important due to the climate changes that are already happening in the producing regions. Some coffee producing countries have already been investing in research to try to find progenies that are better adapted to adverse weather conditions and have greater disease tolerance (CASTILLO et al., 2020).

Analyzing separately the months that obtained the highest rust severity scores, in July, the genotypes P5, P12, P14, P32, P36, M22, G9, G10, G12 and G31 presented the lowest averages than the other genotypes. In February, genotypes P5, P12, P32, M5, M20, M22, M24, G9, G10, and G17 were grouped with lower means. In March, genotypes P23, M20, M22 and G17 presented the lowest means than the others (Table 4). When analyzing separately the months cercosporiosis, two months stood out with the highest severity scores, August and March. There were no differences between the genotypes in the month of August. In March, genotypes P12, P14, P32, M4, M11, M22, M24, G9, G10, G12, G17 and G31 were grouped with the lowest means (Table 5). All evaluated by the Scott- Knott mean cluster test, at 5% error probability.

TABLE 4 - Averages of severity scores for coffee leaf rust in 10 months of evaluation

	Ano 2019							Ano 2020		
G/E	Apr	May	Jul	Aug	Sep	Oct	Nov	Feb	Mar	Apr
P5	4.50Aa	4.13Aa	5.25Ad	2.75Ab	4.00Aa	5.25Ab	5.92Ac	5.75Ab	6.50Ab	7.00Ac
P12	3.00Ba	3.70Ba	5.00Ad	3.50Bb	4.66Aa	5.00Ab	6.17Ac	4.66Ab	5.33Ab	2.00Be
P14	4.00Ba	3.00Ba	4.00Bd	3.83Bb	5.33Ba	4.00Bb	3.50Bc	6.50Aa	10.17Aa	8.33Ac
P23	5.25Ba	3.75Ba	9.17Ac	7.25Aa	7.40Aa	4.92Bb	8.50Ab	8.50Aa	4.00Bc	5.33Bd
P32	4.50Aa	3.30Aa	4.86Ad	3.70Ab	4.60Aa	4.90Ab	4.83Ac	5.60Ab	6.20Ab	3.60Ae
P36	4.00Ba	3.00Ba	5.75Bd	7.20Aa	5.20Ba	5.15Bb	6.08Bc	8.40Aa	10.80Aa	8.00Ac
M4	6.50Aa	4.50Aa	10.00Ac	6.83Aa	6.42Aa	10.00Aa	7.92Ab	7.83Aa	5.67Ab	7.67Ac
M5	4.20Aa	4.50Aa	8.15Ac	5.30Aa	4.20Aa	5.35Ab	5.00Ac	6.00Ab	6.60Ab	7.00Ac
M11	6.00Ba	6.30Ba	15.45Aa	6.30Ba	5.70Ba	12.70Aa	12.58Aa	8.00Ba	7.00Bb	15.00Aa
M20	3.30Aa	3.60Aa	9.35Ac	3.60Ab	4.60Aa	4.65Ab	4.92Ac	5.40Ab	2.80Ac	5.00Ad
M22	3.30Aa	2.80Aa	6.14Ad	3.38Ab	4.00Aa	4.70Ab	5.08Ac	3.50Ab	3.50Ac	5.00Ad
M24	6.08Ba	3.25Ba	8.35Ac	4.60Bb	4.40Ba	5.20Bb	4.17Bc	6.20Bb	9.00Aa	10.60Ab
G9	4.50Aa	3.60Aa	7.20Ad	5.20Aa	4.50Aa	6.00Ab	6.00Ac	6.00Ab	7.60Ab	5.40Ad
G10	3.00Ba	3.00Ba	4.27Bd	2.88Bb	2.70Ba	3.13Bb	4.00Bc	4.25Bb	5.50Ab	7.00Ac
G12	3.30Ba	3.40Ba	6.81Ad	4.38Bb	3.88Ba	4.50Bb	4.75Bc	7.50Aa	7.00Ab	6.25Ad
G16	3.75Ba	3.00Ba	7.70Ac	7.50Aa	5.50Aa	6.90Ab	8.25Ab	7.00Aa	8.80Aa	7.20Ac
G17	4.70Ba	4.20Ba	10.95Ab	7.10Aa	4.60Ba	5.10Bb	5.08Bc	5.40Bb	5.00Bc	7.60Ac
G31	3.75Ba	3.75Ba	4.88Bd	5.75Ba	4.50Ba	4.88Bb	4.17Bc	8.75Aa	8.50Aa	8.25Ac

*Averages followed by the same uppercase letters in the row and lowercase letters in the column constitute a statistically homogeneous group, according to the Scott- Knott test (p<0.05). G/E = Genotype/Evaluation, P = Small, M = Medium, G = Large, Apr = April, May = May, Jul = July, Aug = August, Sep = September, Oct = October, Nov = November, Feb = February.

Hemileia vastatrix it is favored by high relative humidity, low light, and average temperature between 20 and 24°C (GUIMARÃES et al., 2010). Prolonged periods of drought can favor the occurrence of the disease, as it causes stress on the plant, weakening it (MALAU et al., 2021). The *Cercospora coffeicola* infection and development are favored by high relative humidity, excessive sunlight, or high luminosity (GUIMARÃES et al., 2010).

TABLE 5 - Averages of severity scores for cercosporiosis in 10 months evaluated.

				Year 2019						Year 2020
G/E	Apr	May	Jul	Aug	Sep	Oct	Nov	Feb	Mar	Apr
P5	6.00Ba	7.50Aa	3.75Bb	11.25Aa	9.75Aa	7.50Aa	7.50Aa	4.50Bb	10.50Aa	9.00Aa
P12	3.00Ba	5.40Ba	8.00Aa	9.00Aa	14.00Aa	4.00Ba	9.00Aa	7.00Ab	9.00Ab	6.00Ba
P14	5.50Aa	4.50Aa	7.00Ab	5.00Aa	4.50Ab	4.50Aa	6.00Ab	9.00Aa	7.00Ab	5.50Aa
P23	3.50Ba	4.00Ba	9.00Aa	15.50Aa	12.00Aa	4.00Ba	10.50Aa	7.50Aa	12.00Aa	5.50Ba
P32	3.60Aa	3.60Aa	6.60Ab	9.00Aa	7.75Ab	3.60Aa	4.80Ab	5.40Ab	5.40Ab	4.20Aa
P36	3.00Ba	3.50Ba	12.00Aa	10.80Aa	6.60Ab	3.60Ba	7.80Aa	12.00Aa	9.60Aa	3.60Ba
M4	4.50Aa	4.50Aa	5.50Ab	8.50Aa	8.50Ab	4.50Aa	6.00Ab	4.00Ab	7.50Ab	4.50Aa
M5	3.60Ba	6.60Ba	13.80Aa	9.60Aa	9.00Aa	6.60Ba	13.20Aa	11.40Aa	12.00Aa	5.40Ba
M11	4.20Ba	6.60Ba	9.60Aa	9.60Aa	5.40Bb	6.60Ba	12.00Aa	4.80Bb	8.40Ab	5.40Ba
M20	3.60Ba	5.40Ba	9.00Aa	10.80Aa	12.00Aa	5.40Ba	10.20Aa	9.00Aa	13.20Aa	6.60Ba
M22	3.00Ba	3.60Ba	11.25Aa	9.00Aa	7.50Ab	3.75Ba	7.50Ab	9.00Aa	7.50Ab	3.75Ba
M24	4.50Ba	5.50Ba	9.00Aa	13.80Aa	10.80Aa	6.00Ba	9.00Aa	6.60Bb	7.20Bb	6.00Ba
G9	4.80Ba	4.20Ba	7.80Aa	9.60Aa	7.80Ab	4.20Ba	4.20Bb	6.60Ab	7.80Ab	5.40Ba
G10	3.60Aa	4.50Aa	6.00Ab	8.25Aa	5.25Ab	4.50Aa	8.25Aa	4.50Ab	5.25Ab	3.75Aa
G12	3.60Ba	4.20Ba	6.75Ab	9.75Aa	5.25Bb	4.50Ba	8.25Aa	8.25Aa	8.25Ab	3.75Ba
G16	3.50Ba	4.80Ba	13.80Aa	12.00Aa	9.60Aa	4.80Ba	11.40Aa	15.00Aa	10.80Aa	3.60Ba
G17	4.20Aa	4.80Aa	6.00Ab	8.40Aa	6.60Ab	4.80Aa	9.00Aa	4.80Ab	9.00Ab	6.60Aa
G31	3.75Ba	4.50Ba	4.50Bb	8.25Aa	9.75Aa	4.50Ba	8.25Aa	4.50Bb	8.25Ab	3.75Ba

*Averages followed by the same uppercase letters in the row and lowercase letters in the column constitute a statistically homogeneous group, according to the Scott- Knott test ($p<0.05$). G/E = Genotype/Evaluation, P = Small, M = Medium, G = Large, Apr = April, May = May, Jul = July, Aug = August, Sep = September, Oct = October, Nov = November, Feb = February.

For the analyzes according to time, as performed in this work, it is necessary to take into account the latency period for the infection to occur until the plant shows the symptoms of the diseases. For the diseases analyzed, this period can vary from 30 to 60 days (ZAMBOLIM et al. 2005). The months in which there were higher disease severity scores showed that in the latency period there were favorable conditions for their development (Figure 1).

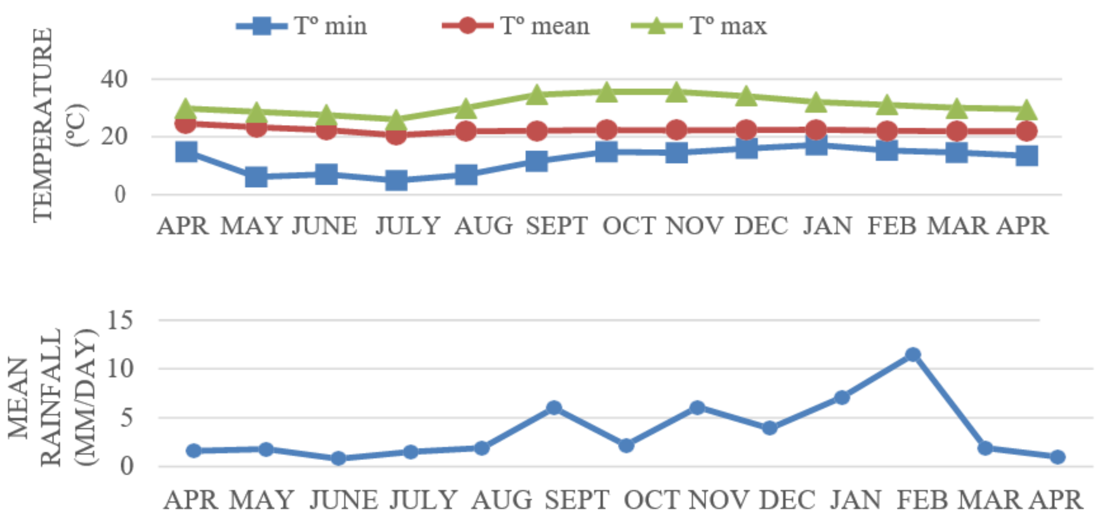

FIGURE 1 - (A) Minimum, average and maximum temperatures in degrees Celsius and (B) average precipitation in mm/day during the 2019/2020 assessment year. Obs: Abr = April, Mai = May, Jun = June, Jul = July, Ago = August, Set = September, Out = October, Nov = November, Dez = December, Jan, January, Fev = February. T° minima = Minimum Temperature, T° media = Mean Temperature, T° máxima = Maximum Temperature.

The interesting thing about analyzing the months with the highest severity scores, both for rust and cercosporiosis, is to observe which genotypes were more tolerant in this period. Genotypes need to express this tolerance when in favorable climatic conditions for the pathogens. It is important to emphasize that this work was evaluated in shoots after harvesting on the coffee plant. This can affect the plant's tolerance to the attack of the analyzed diseases. Plant architecture is an important factor when evaluating diseases, since microclimates can form inside them that can favor or hinder the development of pathogens (COLODETTI et al., 2018).

Another point to be taken into consideration is that the cultivars respond differently to the pruning that is carried out in the crops when necessary. The cultivar Acaiá Cerrado (*Coffea arabica*), responds to pruning vigorously, with rapid recovery and high yield (CARVALHO et al., 2013; CARVALHO et al., 2017). The first evaluation took place approximately 8 months after pruning. As the recepa is a drastic pruning, the coffee plant starts to behave like a juvenile plant again. This makes it more sensitive to the attack of pests and diseases, in addition to the effects of adverse weather conditions (MESQUITA et al., 2016a; MESQUITA et al., 2016b).

Currently, coffee producers are looking for cultivars that have good planting conditions, but in addition, cultivars resistant to diseases. Rust for many years was the main concern of the sector. Today, cercosporiosis is gaining greater importance, as it has also caused economic damage to coffee production. Therefore, cultivars that bring resistance or at least tolerance to both diseases have been sought. Of the genotypes evaluated, when analyzing the selection index by sum of ranks, genotypes G10, P32 and M22 stood out with greater joint tolerance to *Hemileia vastatrix* and *Cercospora coffeicola*, while genotype G16 showed the lowest tolerance to both pathogens (Table 6).

The rank sum index is an efficient method to use in coffee breeding programs, as it is able to identify the best genotype to become a commercial cultivar in the future (CARIAS et al., 2016).

TABLE 6 - Classification of coffee plant genotypes by tolerance to coffee leaf rust, cercosporiosis and to both diseases, simultaneously, considering the selection index of sum of ranks.

Classification of coffee plant genotypes		
Tolerance to coffee leaf rust	Tolerance to cercosporiosis	Selection Index (Sum of ranks)
G10	G10	G10
M22	P32	P32
P12	M4	M22
P32	P14	P14
M20	G31	G12
P5	G9	P12
G12	G12	G9
P14	G17	G31
G9	M22	P5
M5	P36	G17
G31	M11	M4
G17	P12	M20
M24	P5	P36
P36	M24	M24
P23	P23	M5
G16	M20	M11
M4	G16	P23
M11	M5	G16

Some genotypes were considered good candidates for future genetic improvement programs, with the objective of producing larger grains and adding resistance to the main diseases of arabica coffee plant. It is essential to continue with studies on the present genotypes in order to evaluate both diseases during vegetative growth and when they enter the production phase. Therefore, from this new selection of the studied progenies, it is possible to advance generations between and within the families, increasing the genetic variability and enabling the precise selection of elite materials for future commercial cultivars.

CONCLUSION

The genotypes G10, P32 and M22 were more tolerant to coffee leaf rust and cercosporiosis, being good candidates for genetic improvement programs, with the objective of producing larger grains and adding resistance to the main diseases of arabica coffee plants.

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