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Genetic diversity in nutritional parameters in response to drought of *Coffea canephora* cultivated in Rondonia state, Brazil

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ABSTRACT. *Coffea canephora* shows considerable variability for several agronomic traits, including nutritional efficiency. Beside the intrinsic nutritional efficiency of a genotype, the availability of water in the soil is another factor that can cause different responses, which suggests the possibility of selection of genotypes to enhance the nutritional efficiency under different scenarios, such as plantings in areas with low natural fertility or subjected to drought. We evaluated the genetic diversity of genotypes of *C. canephora* that compose the cultivar "BRS Ouro Preto", the first available clonal cultivar recommended for Rondonia State, based on parameters of nutritional status of the plants subjected to cultivation under conditions of abundant water supply or subjected to water deficit. To this end, the experiment was developed with two trials where the 15 genotypes of this cultivar were cultivated in a greenhouse, under conditions of abundant water supply or subjected to water deficit. The trials followed a completely randomized design, with four replications and the mineral status of the plants was evaluated based on the content of N, P, K, Ca, Mg and S of their green tissues. The genotypes presented high variability for these nutritional parameters, making it possible to identify distinct patterns and to group them according to their nutritional status. Variability was affected by drought, showing that the water supply can cause changes in patterns of nutritional status and affect the clustering of genotypes. The genotypic effect surpassed the environmental influence for most mineral parameters, resulting in a desirable scenario for a possible selection to enhance nutritional efficiency, for both irrigated and rainfed systems, within the group of genotypes that already present high yield in Rondonia state.

Key words: Coffee; Genotypes; Mineral nutrition; Multivariate analysis; Variability

INTRODUCTION

The expansion of coffee plantations to the northeast region of Brazil have been successful, especially in the State of Rondônia. However, the availability of adapted cultivars for crops under the common stresses which occurs in this region is still limited, as the majority of currently available coffee cultivars are developed and recommended for the southeast region (Santos et al., 2014). The institute “Embrapa Rondônia”, in partnership with the “Consórcio Pesquisa Café”, after 14 years of research, had launched the first clonal cultivar “BRS Ouro Preto”, developed for farms in Rondônia State. Launched in 2012, this cultivar gathers several desirable agronomical traits, such as uniform maturation, lesser bienniality, high crop yield, large grains, tolerance towards common plant diseases and main abiotic stresses, mainly water deficit (Ramalho et al., 2015).

The clonal cultivar “BRS Ouro Preto” is formed by a group of 15 genotypes selected to be multiplied asexually and cultivated together, the genotypes are compatible among themselves to evade problems caused by the species natural self-incompatibility. This group of genotypes was selected along the years, due to their desirable characteristics and adaptation to the climate and soil conditions of the region, and named in homage to the municipality of Ouro Preto do Oeste, pioneering center of the official colonization of the former Federal Territory of Rondônia (Ramalho et al., 2015).

As fertilizer is responsible for a great part of the production costs in coffee crops, the identification of cultivars with higher nutritional efficiency is an important objective. Clonal cultivars are composed of a group of genotypes that may present different nutritional demands or efficiencies, as well as different tolerances to nutritional stresses. Differences in the nutritional efficiency among genotypes of *Coffea canephora* have been reported for several nutritional parameters (Martins et al., 2013a; Colodetti et al., 2014; Machado et al., 2016; Martins et al., 2015a).

Beside the intrinsic nutritional efficiency of a genotype, the availability of water in the soil can cause alterations in the rate of absorption, translocation and utilization of nutrients by the plant (Fernandes, 2006; Novais et al., 2007). The soil humidity is capable of modulating the movement and adsorption of ions in the soil, having severe effects on the nutritional performance of the coffee plants (Kutywayo et al., 2010; Mera et al., 2011; Souza et al., 2014).

These possible diverse responses suggest the possibility of selection of genotypes of *C. canephora* to enhance the nutritional efficiency under different conditions, such as plantings located in areas of low natural fertility or frequently subjected to of drought.

The objective of this study was to evaluate the genetic diversity among the genotypes of *C. canephora* that compose the cultivar “BRS Ouro Preto”, the first available clonal cultivar recommended for Rondônia State, based on parameters of nutritional status of the plants subjected to cultivation under conditions of abundant water supply or subjected to water deficit.

MATERIAL AND METHODS

Experimental setup

The experiment was conducted in the municipality of Ouro Preto do Oeste, Rondônia state, in northern Brazil. This site has an elevation of 256 m above sea level and its climate is classified as equatorial tropical (warm and humid), being mostly rainy along the year, with a dry season from June to September. The average air temperature ranges from 24°C to 32°C and the average air humidity is 85%.

The experiment consisted of two trials, both following completely randomized design, studying 15 genotypes of *C. canephora*, with four repetitions and one plant per experimental plot. The two trials were different due to differences in the availability of water for the plants during their growth.

Selection of genotypes

The 15 genotypes compose the clonal cultivar “Conilon BRS Ouro Preto” (SNPC Certification number: 20130061) are referred to as 56, 57, 61, 73, 88, 89, 120, 125, 130, 155, 160, 184, 189, 199 and 203. These genotypes went through the stages of selection to form a group with higher adaptation to the main climatic and edaphic conditions present in Rondônia State, Brazil (Ramalho et al., 2015). Matrix-plants (standardized in age, growth, nutritional and phytosanitary status), from a multiplication field, were asexually multiplied using cuttings of their young orthotropic branches (Ferrão et al., 2012). The cuttings were prepared and cultivated in a nursery, following the recommendations of Ferrão et al. (2012). After developing four mature pairs of leaves, the plantlets were selected to form a uniform sample for each genotype and transplanted to plastic pots to compose the experimental plots.

Environmental control for water supply scenarios

The plants were cultivated in controlled environment (greenhouse), accommodated in plastic pots (cylindric, 18 dm^3 internal volume and 34 cm height) filled with 10 kg of soil classified as Oxisol, which was previously prepared to correct its acidity.

The soil was analyzed to determine its hydro-physical characteristics (Embrapa, 1997). Soil humidity at field capacity (tension of 10 kPa) was determined as 24% and at permanent wilting point (tension of 1500 kPa) as 16%, which were used to calculate the available water in the soil and to manage the water supply (Bernardo et al., 2008).

Using that information, two scenarios of water supply were developed to cultivate the plants: (1) The genotypes were cultivated with abundant water supply, daily irrigations were used to return the water availability in the soil to 100% constantly; and (2) the genotypes were subjected to water deficit, the soil humidity was allowed to deplete down to the level of 25% of water availability before the irrigation returned it to the reference level of 100%.

Cultivation and nutritional management

The soil was analyzed to determine its physical-chemical characteristics in order to establish the fertilization management. The fertility of the soil was increased according to adequate levels of each nutrient for the early growth of coffee plants, based on the recommendation for controlled environments (Novais et al., 1991).

The plants were cultivated using the common practices established in accordance with their eventual need and following the current recommendations for the cultivation of Conilon coffee in Brazil (Ferrão et al., 2017). The surface of the soil in each pot was protected and covered with an expanded polystyrene layer in order to avoid water losses by evaporation. After the adaptation period, the irrigation was managed in each trial to cultivate the plants under the different scenarios of water supply from the 50th day after transplanting to the pots until the 170th day of cultivation.

Nutritional parameters

After 170 days of cultivation, the green tissues were cut and separated in paper bags, which were then dried in a laboratory oven (STF SP-102/2000 CIR, with forced air circulation at 65°C), and triturated in blade mill (CIENLAB EC-430, 8 blades, 1,725 rpm, 20 mesh) to obtain a homogeneous powder. Triplicate samples of this powder were used to determine the concentration of each nutrient in the leaves for each experimental plot.

The N content was quantified using samples of 0.5 g (+/-0.001g) of the powder, which were transferred to Taylor tubes (25 mm x 200 mm) and submitted to stages of sulfuric digestion (H_2SO_4), distillation (NaOH 40%) and titration (NaOH 0.02 mol L^{-1}) in a nitrogen distiller (Marconi MA-036), according to the Kjeldahl method (Ma and Zuazaga, 1942).

The content of P, K, Ca, Mg and S were quantified using samples of 0.5 g (+/-0.001g) of the powder, which were transferred to Taylor tubes (25 mm x 200 mm) and submitted to stages of nitric-percloric acid digestion (HNO_3, 65% and $HClO_4$, 70%) in digestion block (Tecnal, TE-007D), at 180-190°C for 3 h; then, 3 mL of ascorbic acid ($C_6H_8O_6$, 0.87M) were added and the determination was made by spectrophotometry (Spectrophotometer, Femto, 700 Plus), following the current methods for chemical analyses in leaf tissues (Embrapa, 1997).

Data analysis

The collected data from each trial was subjected to analyses of variance to identify possible differences in the nutritional contents among the genotypes. The genetic parameters were estimated to each separated scenario based on the model of Cruz et al. (2014):

$$Y_{ij}=\mu+G_i+\varepsilon_{ij} \quad \text{(Eq. 1)}$$

where Y_{ij} represents the phenotypic value of the ij^{th} observation, μ is the general mean, G_i is the fixed effect of the i^{th} genotype, and ε_{ij} is the random error related to the ij^{th} observation.

The genetic divergences between genotypes were estimated based on the nutritional parameters by multivariate analysis techniques for grouping. The Mahalanobis distance was used as dissimilarity measure, and the groups were delineated using an optimization technique based on the Tocher method (as described by Cruz et al., 2014). The analysis of the canonical variables was used to generate graphical dispersions of scores based on the number of variables that allowed for an accumulation of variance of at least 80%. The relative importance of each characteristic in the prediction of genetic divergence was also studies. The analyses were performed using the statistical software GENES (Cruz, 2013).

RESULTS

Variability and genetic parameters

Significant differences for nutritional parameters among genotypes were detected by the analyses of variance for each trial. The highest coefficients of variation (CV) were 19.95% for the environment with abundant water supply and 19.00% for the environment with water deficit, both from the phosphorus content (Table 1).

Table 1. Phenotypic mean variances ($\hat{\sigma}_p$), environmental mean variances ($\hat{\sigma}_e$), quadratic component of the genotypic mean variances ($\hat{\phi}_g$), coefficients of genotypic determination (H^2), coefficients of variation (CV), coefficients of genetic variation (CV_g) and variation index (CV_g/CV) of six nutritional parameters of plants of *Coffea canephora* (cultivar "Conilon BRS Ouro Preto") cultivated with abundant water supply or subjected to water deficit, in Rondônia State, Brazil (2016).

Parameters	N	P	K	Ca	Mg	S
Abundant water supply						
$\hat{\sigma}_p$	10.75	0.29	17.22	2.88	1.27	3.75
$\hat{\sigma}_e$	4.12	0.05	2.43	1.06	0.22	0.88
$\hat{\phi}_g$	6.64	0.23	14.79	1.81	1.05	2.87
H^2 (%)	61.71	51.11	85.88	63.06	82.42	76.64
CV (%)	15.48	19.95	9.51	15.52	16.00	12.42
CV_g (%)	9.83	20.40	11.72	10.14	17.32	11.24
CV_g/CV	0.63	1.02	1.23	0.65	1.08	0.91
Subjected to water deficit						
$\hat{\sigma}_p$	6.48	0.16	5.43	3.39	0.79	6.37
$\hat{\sigma}_e$	3.48	0.04	3.34	0.82	0.18	1.29
$\hat{\phi}_g$	3.00	0.11	2.09	2.56	0.61	5.09
H^2 (%)	46.33	72.87	38.53	75.66	76.78	79.81
CV (%)	13.02	19.00	12.21	13.74	14.29	13.98
CV_g (%)	6.05	15.57	4.83	12.12	12.99	13.90
CV_g/CV	0.46	0.82	0.40	0.88	0.91	0.99

The estimated quadratic components ($\hat{\phi}_g$) showed slightly higher values for most nutritional contents from the plants cultivated in the environment with abundant water supply, showing genotypic variances from this trial 121% higher for N, 109% for P, 16% for K and 72% for Mg in comparison to the trial with plants subjected to water deficit. The estimated values of $\hat{\phi}_g$ surpassed the values of environmental mean variance ($\hat{\sigma}^2_e$) for all nutritional parameters in the trial with abundant water supply. Similar behavior was observed for the trial subjected to water deficit; however, the contents of N and K present lower contribution from the genetic variance in this scenario (Table 1).

Higher coefficients of genotypic determination (H^2) were observed for the contents of K, Mg and S in the trial with abundant water supply and for the contents of P, Ca, Mg and S for the trial subjected to water deficit, showing values above 70%. In addition, the study of these variables showed high estimated values for variation index (CV_g/CV), ranging from 0.82 to 1.23, which represents a favorable condition for identifying diversity among these genotypes, also indicating a higher chance of success for selection processes aimed to explore the nutritional efficiency of these genotypes (Table 1).

Dissimilarity between genotypes

For the genotypes under conditions of abundant water supply, the greatest estimated measure of distance was observed between the genotypes 56 and 199 (D^2 = 58.8), while the smallest measure of dissimilarity was observed between the genotypes 130 and 155 (D^2 = 2.4) (Table 2).

Table 2. Dissimilarity measures between pairs of 15 genotypes of of *Coffea canephora* (cultivar "Conilon BRS Ouro Preto") obtained by Mahalanobis distance and estimated from the study of six nutritional parameters (content of N, P, K, Ca, Mg and S) of plants cultivated with abundant water supply, in Rondônia State, Brazil (2016).

Genotype	57	61	73	88	89	120	125	130	155	160	184	189	199	203
56	7.0	18.9	8.9	19.5	17.2	22.6	25.9	11.5	9.9	32.0	7.6	13.7	58.8	20.7
57		16.9	4.5	6.0	3.0	10.7	10.6	5.4	5.2	14.3	2.6	4.5	33.9	7.1
61			21.0	31.8	16.4	19.9	33.5	11.5	8.1	25.8	11.3	13.6	27.3	18.0
73				7.6	10.6	4.8	7.7	5.2	8.9	11.2	3.7	13.5	34.3	12.0
88					6.6	12.0	8.5	14.2	13.4	12.9	7.9	8.7	27.2	12.9
89						11.1	13.7	6.8	5.2	10.8	5.2	3.8	21.2	3.6
120							9.9	4.6	10.1	3.3	7.4	18.9	18.6	8.8
125								17.2	22.7	14.7	13.7	17.1	32.1	19.0
130									2.4	8.8	3.8	13.0	26.7	3.8
155										14.1	3.5	8.0	25.1	4.5
160											9.9	19.8	14.8	10.8
184												5.2	26.7	9.4
189													27.1	13.2
199														22.5

D^2 maximum: 58.8 (between genotypes 56 and 199); D^2 minimum: 2.4 (between genotypes 130 and 155).

Subjecting the genotypes to cultivation under conditions of water stress promoted differences in the patters of dissimilarity, for this trial, the greatest estimated measure of dissimilarity was observed between the genotypes 89 and 125 (D^2 = 65.7), while the smallest measure was estimated between the genotypes 61 and 130 (D^2 = 1.2) (Table 3).

Table 3. Dissimilarity measures between pairs of 15 genotypes of of *Coffea canephora* (cultivar "Conilon BRS Ouro Preto") obtained by Mahalanobis distance and estimated from the study of six nutritional parameters (content of N, P, K, Ca, Mg and S) of plants subjected to water deficit, in Rondônia State, Brazil (2016).

Genotype	57	61	73	88	89	120	125	130	155	160	184	189	199	203
56	22.8	10.6	10.2	4.7	25.5	4.9	26.1	6.9	3.7	4.1	14.7	11.0	6.3	8.1
57		6.9	14.5	15.6	5.8	22.8	61.5	7.9	18.1	38.9	9.3	8.6	32.0	6.6
61			3.5	8.7	13.8	7.2	36.2	1.2	7.0	19.7	12.6	12.1	17.3	5.7
73				16.0	22.3	7.0	30.6	6.2	9.2	18.3	17.1	17.8	13.5	11.1
88					19.6	9.9	33.5	4.0	3.5	11.4	14.0	9.1	16.5	4.8
89						22.9	65.7	13.5	23.9	36.1	4.1	6.4	30.4	9.2
120							31.5	5.6	6.8	7.0	16.8	15.5	4.0	10.1
125								36.1	22.5	20.6	50.6	55.1	44.4	42.8
130									3.7	15.9	11.8	9.3	13.7	2.7
155										10.8	18.6	15.0	12.9	4.9
160											21.4	20.4	9.8	19.8
184												2.0	21.3	8.9
189													17.5	5.6
199														14.7

D^2 maximum: 65.7 (between genotypes 89 and 125); D^2 minimum: 1.2 (between genotypes 61 and 130).

The Tocher method allowed us to cluster the genotypes in eight different groups for the trial with abundant water supply. Groups ranged from being formed by only one genotype (Groups VII and VIII, formed by only the genotypes 130 and 189, respectively) to three genotypes (Group IV, formed by the genotypes 61, 184 and 203 together) (Table 4).

Table 4. The grouping of 15 genotypes of *Coffea canephora* (cultivar "Conilon BRS Ouro Preto") by the Tocher method based on six nutritional parameters (content of N, P, K, Ca, Mg and S) of plants cultivated with abundant water supply or subjected to water deficit, in Rondônia State, Brazil (2016).

Abundant water supply		**Subjected to water deficit**	
Group	**Genotypes**	**Group**	**Genotypes**
I	73, 89	I	88, 199
II	160, 199	II	89, 189, 130
III	88, 125	III	56, 160, 125
IV	61, 184, 203	IV	57, 61
V	120, 155	V	73, 120
VI	56, 57	VI	155, 184
VII	130	VII	203
VIII	189		

For the trial subjected to conditions of water stress, it was possible to identify seven groups regarding the nutritional parameters. In this scenario, there was only one group formed by only one genotypes (Group VII, formed by the genotype 203 alone), and two groups composed by the clustering of three genotypes (Groups II and III) (Table 4).

The genetic divergence, studied using canonical variables, required additional canonical variables in order to accumulate at least 80% of the overall variation and to make the degree of distortion negligible. Therefore, the first three canonical variables (VC1, VC2 and VC3) were used for both trials, in order to accumulate at least 82.10% of the variation for the trial with abundant water supply and 84.90% for the trial subjected to water deficit (Table 5).

Table 5. Estimate of the eigenvalues and cumulative variances of the canonical variables among 15 genotypes of *Coffea canephora* (cultivar "Conilon BRS Ouro Preto") based on six nutritional parameters (content of N, P, K, Ca, Mg and S) of plants cultivated with abundant water supply or subjected to water deficit, in Rondônia State, Brazil (2016).

Abundant water supply			Subjected to water deficit		
Canonical variables	Eigenvalues	Cumulative variances (%)	Canonical variables	Eigenvalues	Cumulative variances (%)
VC1	2.72	39.31	VC1	4.23	52.49
VC2	1.89	66.63	VC2	1.53	71.54
VC3	1.07	82.10	VC3	1.08	84.90
VC4	0.69	92.12	VC4	0.76	94.29
VC5	0.35	97.13	VC5	0.24	97.23
VC6	0.20	100.00	VC6	0.22	100.00

Relative contribution

Reaffirming the effect of the available water in the soil for the acquirement, translocation and use of the nutrients, it was possible to observe different relative contributions from each nutrient to the variability among the genotypes from each trial. While potassium was responsible for a higher proportion of the overall variability among genotypes cultivated with abundant water supply (26.88%), this nutrient had a smaller contribution under conditions of water deficit (4.07%). Additionally, while the content of calcium had a smaller contribution in the trial with abundant water supply (8.20%), this nutrient had a large contribution in the trial subjected to water deficit (22%; Table 6).

Table 6. Relative contribution of six nutritional parameters (content of N, P, K, Ca, Mg and S) for the diversity observed among genotypes of *Coffea canephora* (cultivar "Conilon BRS Ouro Preto") cultivated with abundant water supply or subjected to water deficit, in Rondônia State, Brazil (2016).

Nutrient content	Relative contribution (%)	
	Abundant water supply	Subjected to water deficit
N	7.51	7.59
P	20.52	19.76
K	26.88	4.07
Ca	8.20	22.01
Mg	22.25	27.93
S	14.64	18.64

Contributions estimated by the method of Singh (1981) based on the Mahalanobis distance (D^2).

DISCUSSION

The nutritional content in plant tissues; the efficiency in which the plants acquire, translocate and utilize the nutrients; and tolerance to cultivation in environment with low fertility have all been successfully used as parameters to study the variability among genotypes of *C. canephora* and to identify groups with different traits (Martins et al., 2013a;

2013b; Colodetti et al., 2014; 2015; Machado et al., 2016; Martins et al., 2015b; Starling et al., 2018). Differences among genotypes were observed for the content of all macronutrients in green tissues, and the magnitude of the genetic parameters showed that nutritional contents can be greatly influenced by the genetic constitution (Table 1).

Under conditions of abundant water supply, the environmental conditions had greater influence over phosphorus; while under water deficit, the environmental effects were higher for nitrogen and potassium (Table 1). This fact may be related to the processes of transportation of these nutrients in the soil and the water requirement to enable it. The water supply modulates both mass flux and diffusion, which are the main transport processes for these nutrients (Novais et al., 2007). Therefore, different scenarios of water supply may magnify the influence of environmental factors in the determination of some nutritional parameters.

Under conditions of abundant water supply, the genotype 199 was one of the most dissimilar among the group, participating in 7 of the 10 largest distances observed in the experiment (with the genotypes 56, 57,61, 73, 88, 125 and 189). Among the dissimilarity measures of this genotype, the smaller dissimilarity was observed with the genotype 160 (Table 2), which together formed the Group II in the clustering for nutritional similarity (Table 4). In this same scenario, the genotype 184 participated of 4 of the 10 smaller distances (with the genotypes 57, 73, 130 and 155) and it was allocated in the Group IV (Table 4), which is the largest group.

The water deficit caused a shift in the patterns of dissimilarities. The genotype 125 participated in 5 of the 10 largest distances (with the genotypes 130, 184, 189, 199 and 203), and was mostly similar to the genotypes 56 and 160 (Table 3), which ended up forming the Group III (Table 4). In this trial, the genotype 155 participated of 4 of the 10 smaller distances (with the genotypes 56, 88, 130 and 203) (Table 3). Groups II and III were formed by a larger number of genotypes, indicating that the divergence among the genotypes that compose them may be more complex to study (Table 4).

The response to changes in soil moisture and the magnitude of expression of the genetic variability being modulated by the amount of water available in the soil for several agronomic traits of coffee plants have been reported by studies assessing other genotypes (Silva et al., 2015; Carvalho et al., 2017; Rodrigues et al., 2017; Bonomo et al., 2018; Starling et al., 2018).

The clustering by the Torcher method allowed to observe some particular patterns in the nutritional content of the genotypes for each trial (Table 4). For the trial with abundant water supply: Group I was formed by genotypes with under average contents of N and above average Mg; Group II clustered genotypes with contents of P, K and Ca above average; Group III presents genotypes with higher contents of Ca and Mg; Group IV present genotypes with lower content of Mg; Group V was formed by genotypes with higher content of K and under average contents of Ca and S; Group VI clustered genotypes with lower contents of P, K and S; Groups VII and VII were formed by only one genotype each.

The trial subjecting the genotypes to water deficit allowed to observe a different behaviour regarding the clustering of the genotypes. Under this conditions, Group I was formed by genotypes with under average contents of MG and higher contents of S; Group II was formed by genotypes with low contents of P; Group III was formed by genotypes with higher contents of Mg; Group IV clustered genotypes with under average contents of P, K, Mg and S; Group V presented genotypes with higher contents of P and lower contents of

Ca; Group VI was formed by genotypes with higher contents of K and lower contents of P and S; Group VII was formed by one genotype alone.

The relative contribution of each nutritional parameter for the differentiation among genotypes indicates that relatively similar patterns for both trials; however, the contributions of potassium and calcium present different behaviours (Table 6). While potassium highly contributed for the different among genotypes and calcium presented a small contribution under abundant water supply, this pattern was swapped when the genotypes were cultivated under conditions of water deficit. This information allows for better planning of new trials (Cruz et al., 1990), as potassium seems to have greater importance in the evaluation of diversity under irrigated conditions and calcium for cultivations subjected to drought.

For the trial with abundant water supply, the graphical dispersion for the first two canonical variables, already allows to observe the separation of the genotype 199 (Figure 1a), reaffirming the participation of this genotype is several high dissimilarity measures. The addition of the third canonical variable made it better to visualize the proximity of this genotype to 160, also the separation of the genotype 189, with was isolated in Group VIII (Table 4).

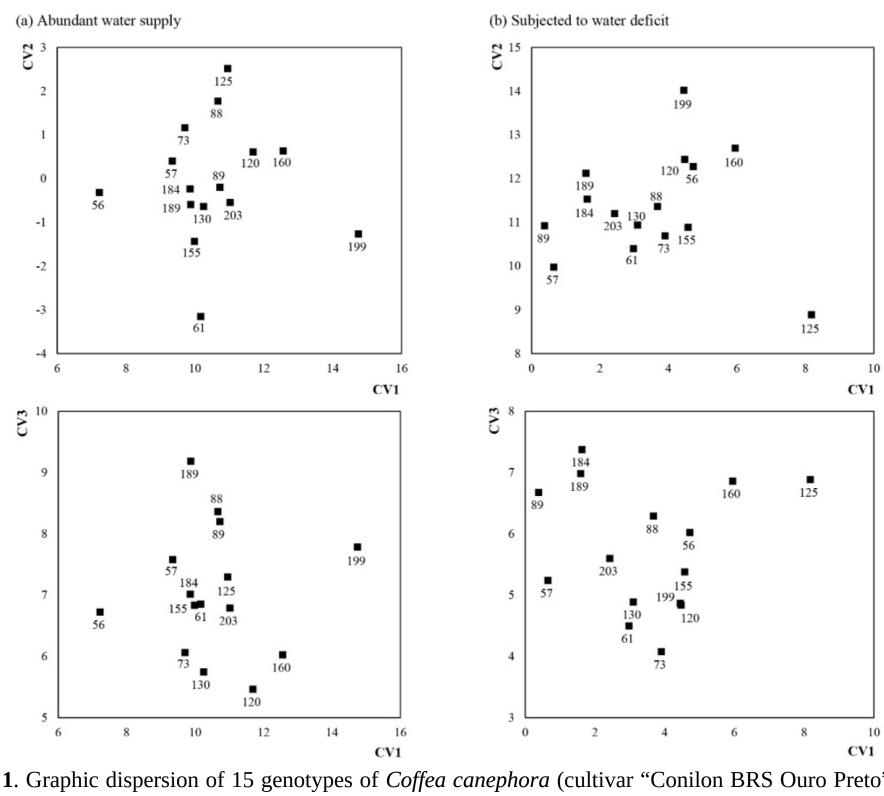

Figure 1. Graphic dispersion of 15 genotypes of *Coffea canephora* (cultivar "Conilon BRS Ouro Preto") for the first canonical variables (CV1 and CV2, CV1 and CV3) based on six nutritional parameters (content of N, P, K, Ca, Mg and S) of plants cultivated with abundant water supply (a) or subjected to water deficit (b), in Rondônia State, Brazil (2016).

Under water deficit, the dispersion for the first two canonical variables shows the separation of the genotype 125 (Figure 1b), which participated in several high dissimilarity measures. The use of the third canonical variable allowed us to better observe the increasing similarity of this genotype with 160 and 56, which all together formed Group III (Table 4).

The use of the first three canonical variables accumulated enough variation to make the degree of distortion negligible; however, it was not sufficient to generate a perfect view of the dispersions of the entire clustering. This same behavior has been described previously in studies of genetic diversity of genotypes of *C. canephora* (Fonseca et al., 2006).

CONCLUSIONS

The genotypes of *C. canephora* that compose the cultivar “BRS Ouro Preto” present high variability for nutritional parameters, making it possible to identify patterns among them and to group them according to their mineral status. The water supply can cause changes in the expression of this variability in mineral composition and the clustering of genotypes is altered when they are cultivated under conditions of water deficit.

For most nutritional parameters, the genotypic effect surpasses the environmental influence, resulting in a desirable scenario for selection to enhance nutritional efficiency, for both irrigated and rainfed systems, within the group of genotypes that already present high yield in Rondônia state, Brazil.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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