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Potencial agronômico e dissimilaridade genética entre cultivares de cafeeiro: Método hierárquico e otimização

Agronomic potential and genetic dissimilarity among coffee cultivars: Hierarchical method and optimization

Potencial agronómico y disimilitud genética entre los cultivares de café: Método jerárquico y optimización

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Resumo

A cafeicultura mineira vem se destacando no cenário nacional devido a grande qualidade na produção e a escolha da cultivar é muito importante durante o processo de implantação da cultura. Estudos de dissimilaridade genética são importantes para conseguir maiores avanços em programas de melhoramento genético para obtenção de cultivares mais adaptadas. Com isso o objetivo da realização do trabalho foi avaliar a dissimilaridade genética entre cultivares de cafeeiros baseado nos métodos hierárquico e otimização. O experimento foi instalado na Universidade Federal de Uberlândia, *Campus* - Monte Carmelo. O plantio foi realizado em dezembro de 2015, utilizando-se o delineamento em blocos casualizados com quatro repetições. Foi adotado espaçamento de 3,5 m entre linhas e 0,6 m entre plantas. Os tratamentos foram constituídos por sete cultivares: Acaiá Cerrado - MG 1474; Mundo Novo IAC 379-19; Bourbon Amarelo IAC J10; Catuaí Vermelho IAC 99; Topázio MG 1190; Acauã Novo e IAC 125 RN. Foram realizadas avaliações de crescimento, produtividade da primeira safra da lavoura e classificação física quanto ao tipo, tamanho e formato de grãos do café. Houve coerência entre os métodos hierárquicos e de otimização na formação dos grupos. A cultivar Mundo Novo IAC 379-19 foi que apresentou maior vigor vegetativo. A cultivar Acaiá Cerrado MG 1474 foi a que obteve maior produtividade na primeira safra. A cultivar Topázio MG 1190 apresentou maior dissimilaridade genética em relação às demais cultivares. Os métodos de análise multivariada UPGMA e otimização de Tocher indicaram que as cultivares possuem variabilidade genética para a região em estudo.

Palavras-chave: Análise multivariada; Variabilidade genética; *Coffea arabica* L.

Abstract

The coffee growing in Minas Gerais has been outstanding due to the high quality in the production and the cultivar choice is very important during the culture implantation process. Genetic dissimilarity studies are very important to make further advances in breeding programs to obtain more adapted cultivars. Thus, the objective of this work was to evaluate the agronomic potential and genetic dissimilarity among coffee cultivars based on hierarchical and optimization methods. The experiment was installed at the Federal University of

Uberlândia, *Campus* - Monte Carmelo. The planting was carried out in December 2015, using a randomized block design with four replications. A spacing of 3.5 m between rows and 0.6 m between plants was adopted. The treatments consisted of the *Coffea arabica* cultivars: Acaiá Cerrado - MG 1474; Mundo Novo IAC 379-19; Bourbon Amarelo IAC J10; Catuaí Vermelho IAC 99; Topázio MG 1190; Acauã Novo and IAC 125 RN. Growth, crop yield and physical classification were evaluated for type, size and shape of coffee beans. There was consistency between hierarchical and optimization methods in the groups formation. The cultivar Mundo Novo IAC 379-19 showed the highest vegetative vigor. The cultivar Acaiá Cerrado MG 1474 was the one that obtained the highest yield in the first crop. The cultivar Topázio MG 1190 showed higher genetic dissimilarity compared to the other cultivars. UPGMA multivariate analysis and Tocher optimization methods indicated that the cultivars have genetic variability for the region under study.

Keywords: Multivariate analysis; Genetic variability; *Coffea arabica* L.

Resumen

El café de Minas Gerais se ha destacado en la escena nacional debido a la alta calidad de producción y la elección del cultivar es muy importante durante el proceso de implantación del cultivo. Los estudios de disimilitud genética son importantes para lograr mayores avances en los programas de mejora genética para obtener cultivares más adaptados. Por lo tanto, el objetivo de la realización del trabajo fue evaluar la diferencia genética entre los cultivares de cafeto con base en métodos jerárquicos y de optimización. El experimento se instaló en la Universidad Federal de Uberlândia, Campus - Monte Carmelo. La siembra se realizó en diciembre de 2015, utilizando un diseño de bloques al azar con cuatro repeticiones. Se adoptó una separación de 3.5 m entre líneas y 0.6 m entre plantas. Los tratamientos consistieron en siete cultivares: Acaiá Cerrado - MG 1474; Mundo Novo IAC 379-19; Bourbon Amarelo IAC J10; Catuaí Vermelho IAC 99; Topázio MG 1190; Acauã Novo y IAC 125 RN. Se realizaron evaluaciones de crecimiento y productividad del primer cultivo y clasificación física en cuanto al tipo, tamaño y forma de los granos de café. Hubo coherencia entre los métodos jerárquicos y de optimización en la formación de grupos. El cultivar Mundo Novo IAC 379-19 mostró el mayor vigor vegetativo. El cultivar Acaiá Cerrado MG 1474 fue el que obtuvo la mayor productividad en la primera cosecha. El cultivar Topázio MG 1190 mostró una mayor disimilitud genética en relación con los demás cultivares. Los métodos de análisis multivariante UPGMA y la optimización de Tocher indicaron que los cultivares tienen variabilidad genética para la región en estudio.

Palabras clave: Análisis multivariante; Variabilidad genética; *Coffea arabica* L.

1. Introduction

Regarding the historical context of Brazil, it is noted that the cultivation of arabica coffee (*Coffea arabica* L.) is very nationally important. With a total planted area of 2.16 million hectares, for the 2020 harvest, a production between 57.1 and 62.0 million bags benefited is expected. For the Cerrado Mineiro region (Triangulo Mineiro, Alto Paranaíba and Northwest of the state) it is estimated a production of 5.8 million bags benefited (National Supply Company [CONAB], 2020).

Conditions that are usually favorable for higher coffee productivity are also beneficial to growth. Thus, the larger the plant and productive branches, the greater the production (Matiello, et al., 2010). Regions such as Alto Paranaíba, covering the Cerrado Mineiro, provide high production of this crop (Ortega & Jesus, 2011). There are 132 cultivars registered with the Ministry of Agriculture, Livestock and Supply (MAPA, 2020), with different sizes, resistance to rust and nematodes and adapted to different cultivation regions. The use of multivariate analysis for the genetic dissimilarity study has been very important in the planning of breeding programs and in the work strategies definition (Guedes, et al., 2013).

Despite the diversity of cultivars present in the national coffee park, there is still a predominance of strains from Catuaí and Mundo Novo (Matiello, et al., 2015). In this sense, research developed with cultivars such as IAC 125 RN, Acauã Novo and Paraíso has become promising to evaluate their productive potential in different coffee regions. Clustering methods aim to unite genotypes into groups, thus obtaining heterogeneity between groups and homogeneity within the group (Kloster, et al., 2011). The *Unweighted PairGroup Method Using Arithmetic Averages* (UPGMA) hierarchical method uses the averages distances between pairs of genotypes for group formation, whereas the Tocher optimization method differs from the hierarchical method in that the formed groups are mutually exclusive, based on a certain grouping criterion (Cruz, Carneiro & Regazzi, 2014).

The use of multivariate techniques to estimate genetic dissimilarity has become common and is employed in several species; tomatoes (Maciel, et al., 2018; Finzi, et al., 2019), common bean (Correa & Gonçalves, 2012), pumpkin (Ferreira, et al., 2016), corn (Nardino, et al., 2017) and soybean (Almeida, Peluzio & Afférri, 2011), with little research on coffee germplasm evaluation. In this context the objective of the study was to evaluate the genetic dissimilarity among coffee cultivars based on hierarchical and optimization methods in the Alto Paranaíba region, MG.

2. Methodology

The experiment was conducted at the Federal University of Uberlândia, *Campus* Monte Carmelo. The geographical coordinates of the experimental area are 18°43'41"S and 47°31'26"W, located at an altitude of 903 m. The evaluations performed in the experiment occurred from August 2015 to July 2017. The method used in the present study was quantitative (Pereira, et al., 2018).

The soil of the experimental area is classified as RED LATOSOL (Oxisol). Soil samples of 0-20 cm were collected for chemical soil classification at the beginning of the experimente implementation in 2014 and also in August 2015 and 2016 (Table 1).

Table 1. Chemical characterization of soil in the experimental area in 2014, 2015 and 2016.

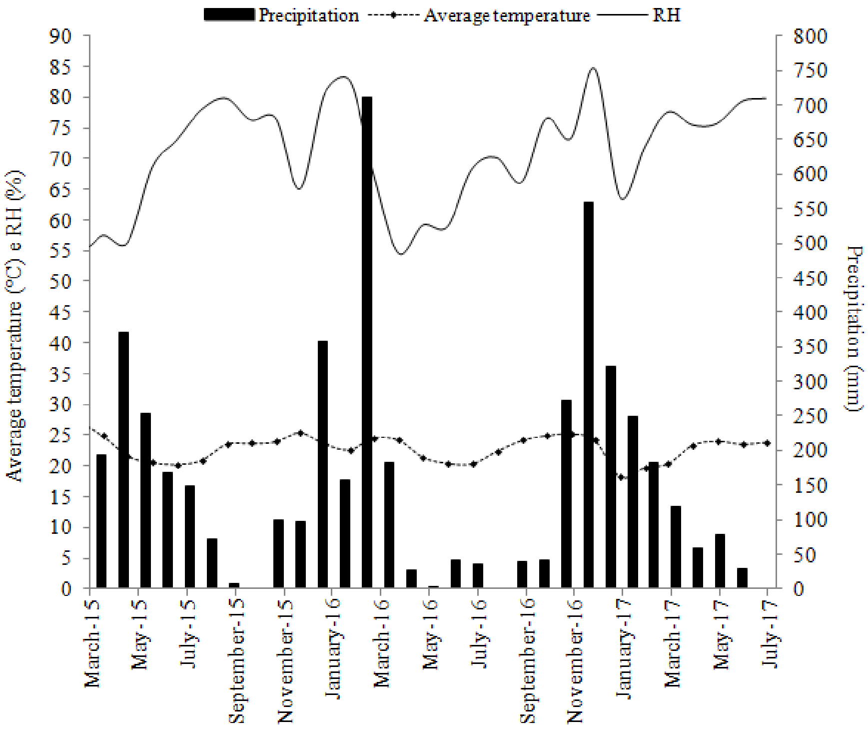
Characteristic	2014	2015	2016
pH (H_2O)	6.2	5.8	5.5
Phosphorus (P) – mg dm $^{-3}$	38.8	6.4	18.6
Potassium (K) - mg dm $^{-3}$	260.0	154.0	134.0
Calcium (Ca^{2+}) – cmolc dm $^{-3}$	2.8	1.1	3.8
Magnesium (Mg^{2+}) – cmolc dm $^{-3}$	1.2	0.8	1.5
Aluminum (Al^{3+}) – cmolc dm $^{-3}$	0.0	0.0	0.0
H+Al (Extractor SMP) – cmolc dm $^{-3}$	2.6	3.4	2.2
Exchangeable base sum (SB) – cmolc dm $^{-3}$	4.7	2.3	5.6
Cation exchange capacity - CTC (t) - cmolc dm $^{-3}$	4.7	2.3	5.6
CTC a pH 7.0 (T) - cmolc dm $^{-3}$	7.3	5.7	7.8
Base saturation index (V) - %	64.0	40.0	72.0
Aluminum Saturation Index (m) - %	0.0	0.0	0.0
Zinc (Zn) – mg dm^{-3}	4.3	2.9	4.7
Iron (Fe) – mg dm^{-3}	81.0	20.0	21.0
Manganese (Mn) – mg dm^{-3}	3.3	4.2	3.1
Cuprum (Cu) – mg dm^{-3}	2.7	2.3	2.0
Boron (B) – mg dm^{-3}	0.1	0.4	0.4

Source: Authors.

The treatments consisted of seven coffee cultivars: Acaiá Cerrado - MG 1474, Mundo Novo IAC 379-19, Bourbon Amarelo IAC J10, Catuaí Vermelho IAC 99, Topázio MG 1190, Acauã Novo and IAC 125 RN. A randomized block design with four replications was used. Each experimental plot consisted of a row with ten plants in the 0.6 m spacing, considered useful the eight central plants.

The experiment was planted in January 2015, under favorable precipitation conditions for the appropriate establishment of the crop (Marchi, et al., 2003). The environmental condition during culture establishment until the evaluation day were monitored (Figure 1).

Figure 1. Precipitation, average temperature and relative humidity during the experiment at the Federal University of Uberlândia, Monte Carmelo, 2015-2017.



Source: Sismet Cooxupé.

The planting furrows were spaced 3.5 m apart and received 7.0 L planting hole^{-1} bovine organic fertilizer and 195 g planting hole^{-1} simple superphosphate mineral fertilization (18% P_2O_5) as recommended by Ribeiro, Guimarães & Alvarez (1999). In the first year after planting was applied 40 g of N per plant per year in four installments between November and February, 10 g of K_2O per plant per year and 300 kg ha^{-1} of limestone with PRNT (Relative Power of Total Neutralization) corresponding to 85%. In the second year after planting, considering expected yield of 20 to 30 bags hectare^{-1} of 60 kg of processed coffee, 250 kg hectare^{-1} of N and 125 kg hectare^{-1} of K_2O were applied. These were split in four times and applied at 30-day intervals, beginning in December 2016. Phosphate fertilization was not performed due to the satisfactory levels of this nutrient found in the soil. Phytosanitary management was carried out by periodic evaluations in the field to determine the need for pest, disease and weed management.

In March 2017, the following growth characteristics were evaluated:

- ✓ Plant Height (Height) - Measured from the neck to the point of insertion of the terminal bud with a ruler, in centimeters.
- ✓ Stem diameter (S. diameter) - measured with a caliper, 1 cm from the plant's neck, in centimeters.
- ✓ Canopy diameter (C. diameter) - measured with a ruler, taking as standard the two branches in the direction of the rows with the longest length, in centimeters.
- ✓ Number of nodes per primary plagiotropic branch (Nodes Below and Nodes Above) - obtained by counting nodes in a plagiotropic branch located in the middle third of the plant, on both sides of the plant.
- ✓ Length of plagiotropic branches (L. branch) - Determined by measuring a plagiotropic branch located in the middle third of the plant, from its insertion in the orthotropic branch to the end of the plagiotropic branch.
- ✓

To evaluate the productivity and physical classification of coffee for the first crop in 2017, the following characteristics were evaluated:

- ✓ Productivity of processed coffee (bags hectare^{-1}): Harvesting was carried out on each useful plot by hand melting on the cloth, starting in July. Because the cultivars presented different ripening times, the harvest was staggered, starting when the percentage of green fruits was below 10%. After determining the volume produced by the plot, a 10 L sample was taken and dried in a suspended yard. After reaching a moisture of 11%, the mass and volume of the coffee grains were determined. Subsequently, the samples were benefited and the mass, volume and moisture of the coffee were determined again. Based on the relation of the 10 L sample volume of the coffee harvested in the cloth and the benefited sample mass, the yield per plot was determined and later extrapolated to productivity in bags hectare^{-1}.

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✓ Ripening: A representative sample of 0.3 L was taken from each plot to separate the fruits at different ripening stages (green, cane green, cherry, raisin and dry).

✓ Physical classification according to type: after processing, the coffee harvested was classified according to type (depending on the number of defects). Intrinsic defects (black, green, burned, shells, broccoli, faulty and broken) and extrinsic defects (sticks, stones, clods, barks, sailors and grain) were identified in a 300 g sample. The number of defective grains in each class was counted to determine the equivalence of defects for classification according to type as per MAPA (2003).

✓ Physical grading for grain size and shape: For grading grain size and shape, a 100 g sample from each experimental plot was distributed on a set of circular sieves (19, 18, 17, 16, 15, 14 and 13/64 inch) and oblong screen (13, 12, 11, 10, 9 and 8/64 inch). Circular sieves retain flat coffee while oblong sieves separate the "moca" coffee beans. Subsequently, the separation was performed in the following categories: Big flat: sieves 19, 18 and 17; Medium flat: sieves 16 and 15; Smaller flat: sieve 14 and smaller; Big "moca": sieves 13, 12 and 11; Medium "moca": sieve 10 and Small "moca": sieve 9 and smaller.

Descriptive statistical analysis was performed for the agronomic characters of the cultivars. Then, multivariate analysis were performed with the parameters of growth and yield of coffee tree in order to determine the genetic dissimilarity between cultivars, obtaining the dissimilarity matrix by the Mahalanobis generalized distance. Genetic dissimilarity was represented by dendrogram obtained by the UPGMA hierarchical method and by the Tocher optimization method. The relative contribution of quantitative characters was calculated according to Singh's criterion (1981). All data obtained were analyzed using the software Genes v. 2015.5.0 (Cruz, 2013).

3. Results and Discussion

The defects, height (cm), canopy diameter (cm) and cherry fruits (%) variables presented the highest values of variance. This indicates high dissimilarity among the cultivars studied for these characteristics evaluated. The variables with the lowest values of variance were stem diameter (cm), percentage of small "moca" grain, percentage of medium flat grain and percentage of medium "moca" grain, showing the proximity of cultivars to these characteristics (Table 2).

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In general, the cultivars presented low average for the variable percentage of small "moca" grains and medium "moca" grains being considered a great result, because these types of grains are not desired in the most demanding markets. The maximum value of total percentage of flat grain was obtained by Mundo Novo IAC 379-19 cultivar, standing out among the other cultivars evaluated (Table 2). Franco Junior, et al. (2019) reported that grains retained in larger sieves obtained fewer defects than smaller ones.

Regarding productivity (bags hectare^{-1}), a variance of 28.49 can be observed, with an average yield of 13.73 bags hectare^{-1}, which is not considered satisfactory. The cultivar with the highest yield was Acaiá Cerrado - MG 1474. In contrast, the Bourbon Amarelo IAC J10 cultivar presented the minimum value. Pereira, et al. (2011) using 3.5m row spacing observed an average yield of 24 bags hectare^{-1} in the first two harvests (12 bags hectare^{-1} per crop), which corroborates the data found in the study.

Table 2. Descriptive statistical analysis for agronomic characters of coffee cultivars.

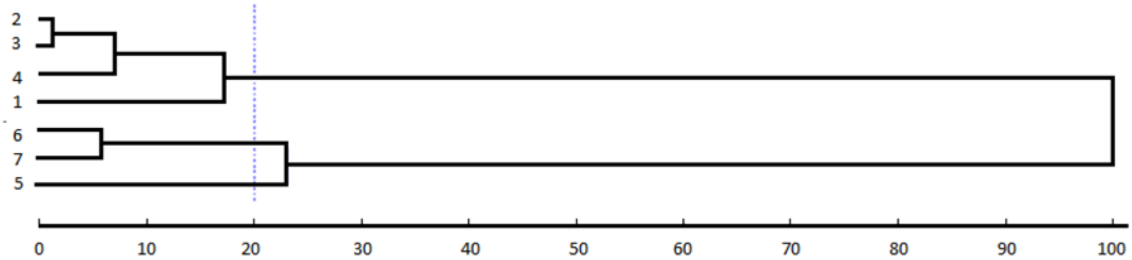
Variable	Variance	Average	Maximum (cultivar)	Minimum (cultivar)
Defects	1619.38	172.46	216.00 (Catuaí)	104.00 (Bourbon)
Big flat (%)	72.22	54.55	63.98 (IAC 125 RN)	39. 25 (Topázio MG)
Medium flat (%)	17.91	14.98	20.08 (Topázio)	8.93 (IAC 125 RN)
Small flat (%)	0.22	1.45	2.13 (Topázio)	2.13 (Bourbon)
Big “moca” (%)	10.88	22.14	29.25 (Topázio)	18.80 (Mundo Novo)
Medium “moca” (%)	1.98	5.26	7.38 (Acauã Novo)	3.73 (IAC 125 RN)
Small “moca” (%)	0.14	1.54	2.18 (Topázio)	0.93 (IAC 125 RN)
Total flat (%)	21.23	71.00	75.18 (Mundo Novo)	61.38 (Topázio)
Total “moca” (%)	21.25	28.92	38.55 (Topázio)	24.80 (Mundo Novo)
Green (%)	11.26	6.32	11.80 (Mundo Novo)	2.85 (Topázio)
Cane green (%)	7.36	4.78	8.55 (IAC 125 RN)	1.35 (Topázio)
Cherry (%)	96.78	66.48	77.93 (Mundo Novo)	51.90 (Acauã Novo)
Raisin (%)	47.44	14.62	27.23 (Topázio)	3.78 (Mundo Novo)
Dry (%)	53.13	7.81	18.73 (Catuaí)	0.85 (Mundo Novo)
Productivity (bags ha^{-1})	28.49	13.73	19.83 (Acaiá Cerrado)	6.90 (Bourbon)
S. diameter (cm)	0.15	3.87	4.44 (Mundo Novo)	3.21 (Acaiá Cerrado)
C. diameter (cm)	132.96	123.60	142.17 (Mundo Novo)	107.75 (Acaiá Cerrado)
Height (cm)	350.09	108.55	135.83 (Mundo Novo)	87.92 (Acaiá Cerrado)
L. branch (cm)	34.00	64.23	74.38 (Bourbon)	57.83 (Catuaí)
Nodes Below	4.80	19.23	22.67 (Topázio)	16.67 (IAC 125 RN)
Nodes Above	4.22	19.50	22.59 (Topázio)	16.92 (Mundo Novo)

Source: Authors.

The Mundo Novo IAC 379-19 cultivar stood out among the others in relation to the maximum values of height (cm), stem diameter (cm) and canopy diameter (cm) indicative of good vegetative vigor of the plants. The Acaiá Cerrado MG 1471 cultivar showed inferior performance for the same variables. The Bourbon Amarelo IAC J10 cultivar was superior to the others for characteristic plagiotropic branch length. Carvalho, et al. (2010) observed genotypic correlation between stem diameter and yield, and phenotypic correlation of plant height, stem diameter, and plagiotropic branch length with yield. Assis, et al. (2014) did not notice correlation between stem diameter and yield, but observed that plant height correlates with yield in irrigated crops. These results contradict those found in the study where the Acaiá Cerrado MG 1474 cultivar presented low growth values and was superior in relation to the others in yield. The Topázio MG 1190 cultivar was prominent in relation to the number of nodes, which may have a positive impact on the next harvest, as this characteristic is directly related to the flower buds emission and consequently to the number of fruits.

The dendrogram by the UPGMA method was generated from the dissimilarity matrix by the Mahalanobis distance (Figure 2). The groups delimitation was made from a cut line considering 20% similarity between the genotypes. The cut line was established at the place where there was an abrupt change in the branches present in the dendrogram (Cruz, 2013).

Figure 2. Illustrative dendrogram of the analysis of seven coffee cultivars by the average group bonding method (UPGMA) obtained with the Mahalanobis distance with average generated from 21 variables. 1 = Acaiá Cerrado MG1474; 2 = Mundo Novo IAC 379-19; 3 = Bourbon Amarelo IAC J10; 4 = Catuaí Vermelho IAC 99; 5 = Topázio MG 1190; 6 = Acauã Novo; 7 = IAC 125 RN.



Source: Authors.

With this cut one has the formation of three distinct groups. Group I was formed by 57.14% of the cultivars, represented by Mundo Novo IAC 379-19, Bourbon Amarelo IAC J10, Acaiá Cerrado MG 1474 and Catuaí Vermelho IAC 99. Group II consisted of the cultivars Acauã Novo and IAC 125 RN and group III by the Topázio MG 1190 cultivar (Figure 2). Guedes, et al. (2013) separated 12 accessions of Maragogipe variety arabica coffee in 7 distinct groups by the UPGMA method with a 15% dissimilarity cut. Silva, et al. (2017) reported the formation of 9 distinct groups using 13 conilon coffee clones with an 18%

dissimilarity cut. Moura, et al. (2015) using the UPGMA dendogram reported the presence of the cultivars Topázio MG 1190 and Acaiá Cerrado MG 1474 in different groups, which corroborates the data found in the study. It is noteworthy that all group I genetic materials have in common the presence of some cultivar of the Mundo Novo group in their genealogy, and Acaiá Cerrado MG 1474 and Catuaí Vermelho IAC 99 were originated from group selections and plant crosses of Mundo Novo group, respectively (Carvalho, et al., 2008). It is suggested that these factors may justify the framing of these cultivars in the same group (Figure 2).

Cultivars belonging to the same group are similar, while cultivars from different groups are divergent. Thus, the use of cultivars from different groups in breeding programs becomes important to generate genetic variability. The use of Mundo Novo IAC 379-19 and Acauã Novo cultivar as parents of a breeding program would be feasible, as Mundo Novo has high vegetative vigor, due to the increase in stem diameter, height and length of the plagiotropic branch of the plants and Acauã Novo is highly resistant to rust (*Hemileia vastatrix*) and tolerant to the nematode *M. exigua*.

With the Tocher method, the results were similar to those found by the UPGMA method, mainly using the minimum similarity limit of 20% among the cultivars to fit them in the same group. Thus, all groups found in the UPGMA method were identical to the groups formed by the Tocher method, which indicates the coherence in the formation of the groups between the methods (Table 3).

Table 3. Tocher clustering in seven arabica coffee cultivars, based on the dissimilarity expressed by the Mahalanobis generalized distance, estimated from 21 evaluated variables.

GROUP	CULTIVARS
I	Acaiá Cerrado – MG 1474; Mundo Novo IAC 379-19; Bourbon Amarelo IAC J10, Catuaí Vermelho IAC 99
II	Acauã Novo; IAC 125 RN
III	Topázio MG 1190

Source: Authors.

Evaluating genetic dissimilarity in robusta coffee progenies, Ivoglo et al. (2008) also found coherence between the two UPGMA and Tocher grouping methods according to the Mahalanobis generalized distance. Viana, et al. (2018) evaluating the genetic variability in coffee rust-resistant genotypes found coherence between the two methods when applying the 35% dissimilarity cut in the dendrogram.

The Topázio MG 1190 cultivar formed an isolated group in both clustering methods, being therefore the cultivar with higher dissimilarity than the others (Table 3) (Figure 2). The cultivar with the highest genetic distance compared to Topázio MG 1190 was Acaiá Cerrado - MG 1474 and the cultivar with the shortest distance was IAC 125 RN. Studying 88 coffee accessions from the Epamig germplasm bank, Silva, et al. (2013) obtained the formation of 19 groups evaluating quantitative data and 12 groups evaluating multi-categorical data. Evaluating only vegetative characters Pedrosa, et al. (2013) found the presence of the Topázio cultivar in the same group as the Acaiá Cerrado cultivar and the Paraíso cultivar. This indicates that the number of variables used as parameters to obtain the cultivars' genetic dissimilarity influences the formation of groups.

Singh's method (1981) was used to measure the relative importance of characters and their relative contribution to the formation of groups. The characteristics that most contributed to the cultivars' differentiation were the percentage of cherry fruits (30.49%), the percentage of green fruits (18.91%) and the percentage of big "moca" grains (17.18%) (Table 4).

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Table 4. Relative contribution (%) of characters to genetic dissimilarity in coffee cultivars estimated by the method proposed by Singh (1981).

Variables	R.C	V% Trail 1	V% Trail 2
Defects	0.00	0.00	-
Big flat (%)	950021.63	14.08	14.08
Medium flat (%)	0.00	0.00	-
Small flat (%)	0.00	0.00	-
Big “moca” (%)	1158910.83	17.18	17.18
Medium “moca” (%)	347656.38	5.15	-
Small “moca” (%)	91991.70	1.36	-
Total flat (%)	0.00	0.00	-
Total “moca” (%)	51759.93	0.77	-
Green (%)	1275631.55	18.91	18.91
Cane green (%)	655331.49	9.71	9.71
Cherry (%)	2057200.02	30.49	30.49
Raisin (%)	0.00	0.00	-
Dry (%)	0.00	0.00	-
Productvity (bags hectare^{-1})	35453.43	0.53	0.53
S. diameter (cm)	0.00	0.00	-
C. diameter (cm)	87346.21	1.29	1.29
Height (cm)	0.00	0.00	-
L. branch (cm)	35094.54	0.52	-
Nodes below	0.00	0.00	-
Nodes above	0.00	0.00	-

R.C = relative contribution; V% TRAIL 1 = value as a percentage of relative contribution; V% TRAIL 2 = value in % of a second data screening. Source: Authors.

These three variables contributed 66.58% of genetic dissimilarity while the others contributed 33.42% which shows their importance in the formation of groups. The characters height (cm) and stem diameter (cm) presented zero relative contribution, which corroborates the results found by Guedes, et al. (2013) who obtained results of 0.9% and 1.1% relative contribution to these characteristics, respectively, showing that they can be discarded in studies of genetic dissimilarity. Celestino, Malaquias & Xavier (2015) used the method to measure relative importance of variables related to drink quality of different coffee cultivars.

Guedes, et al. (2013) stated that characteristics that are moderately little variant among the studied accessions, which manifest instability with the modification of experimental situations or are related to another characteristic, are unnecessary in studies of genetic dissimilarity. In a second data screening, the characteristics that presented zero relative contribution would be discarded along with the low contribution ones. The productivity trait would be maintained in a second screening, as it is an important variable in coffee selection. Ivoglo et al. (2008) found divergent results where productivity contributed 10.53% by the Singh method (1981) in genetic dissimilarity.

As it is a perennial crop, it is suggested that this research be carried out over several biennia, aiming to evaluate the productive behavior of cultivars in alternating years of low and high production.

4. Final Considerations

The highest vegetative vigor was observed in Mundo Novo IAC 379-19 cultivar.

The Acaiá Cerrado MG1474 cultivar stood out in relation to productivity.

UPGMA multivariate analysis and Tocher optimization methods indicated that the cultivars have genetic variability.

There was coherence between the hierarchical and optimization method in the group formation.

The Topázio MG 1190 cultivar was the one with the highest dissimilarity.

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