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MONTE PASCOAL: FIRST CLONAL CONILON COFFEE CULTIVAR FOR SOUTHERN BAHIA - BRAZIL

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Abstract: Monte Pascoal is a *Coffea canephora* cultivar derived from clones discovered and bred by farmers. It was evaluated at 140 m asl in the South of Bahia – Brazil for yield, plant vigor and pest and disease resistance. The cultivar with six genotypes produces a mean yield of 130 bags ha^{-1} $year^{-1}$.

Keywords: *Coffea canephora*, plant resistance, climate change.

Introduction

Worldwide, around 174 million bags of coffee are produced every year. Of this total output, 59.8% is coffee of the species Arabica (*Coffea arabica*) and 40.2% Robusta/Conilon (*C. canephora*) (USDA, 2020). The entire coffee chain accounts for an annual revenue of around 172,000 million U$D (ICO, 2020), and Brazil for approximately 32% of the global production (CONAB, 2020). In expectation of the predicted population growth and climate changes, efforts to raise coffee yields and quality by sustainable and environmentally responsible actions should be doubled.

Approximately 30% of the coffee produced in Brazil is Conilon/Robusta coffee. The State of Bahia is the third largest producer of this *Coffea* species. The almost two million bags of green coffee (60 kg bag^{-1}) are mostly harvested in the south of Bahia, on an area of over 40 thousand hectares (CONAB, 2020), in other words, this is an economically essential crop for Bahia.

Conilon coffee is a self-sterile and diploid plant and, as indicated by the gametophytic self-incompatibility, also allogamous (Nowak et al., 2011; Vázquez et al., 2019). Vegetatively propagated plants inherit and thus maintain the traits of the mother plant, which warrants a uniform crop development, higher yields, better fruit quality and makes the selection of varieties with different maturation cycles possible (Partelli et al., 2014b; Partelli et al., 2019; Partelli et al., 2020).

Coffea canephora is tolerant to temperatures up to 37 ºC by maintaining or intensifying photoprotective and antioxidant mechanisms (Martins et al., 2016; Rodrigues et al., 2016).

At mean temperatures lower than 17 ºC or higher than 31 ºC, the growth of *C. canephora* trees is retarded (Partelli et al., 2010; Covre et al., 2016). In the second case, grain weight and yield can be reduced by the heat affecting the plant physical characteristics (Ramalho et al., 2018). An alternative to mitigate heat stress is to cultivate coffee in the shade of other tree crops (Partelli et al., 2014a; Oliosi et al., 2016).

Under cold, heat and water stress, different levels of some tolerance characteristics were observed in the field, according to the *Coffea* genotypes (Covre et al., 2016; Gomes et al.,

2016; Dubberstein et al., 2017; Giles et al., 2019; Partelli et al., 2019).

In terms of climatic suitability, Monte Pascoal is a *C. canephora* cultivar indicated for cultivation at low altitudes. The six Monte Pascoal genotypes were tested in the field at 140 m asl and registered by the Brazilian Ministry of Agriculture, Livestock and Food Supply (MAPA - Link: http://sistemas.agricultura.gov.br/snpc/cultivarweb/cultivares_registradas.php).

Breeding process

A group of 43 promising *C. canephora* genotypes was chosen, most of which had been selected by coffee farmers in the State of Espírito Santo - Brazil. These 42 cutting- and one seed-propagated genotypes were propagated again by cuttings and planted in an experimental plot for selection for high yield potential and agronomic traits of interest. The experiment was planted in April 2014, at a spacing of 3.5 m x 1.0 m, totaling 2,857 plants ha^{-1}, in the county of Itabela, Bahia, Brazil (lat 16° 36′ 52.00″ S, long 39° 30′ 33.00″ W, alt 140m asl). According to Köppen's classifycation, the regional climate is Aw tropical, with hot humid summers and dry winters (Alvares et al., 2013), mean minimum temperatures of over 15 °C (July and/or August) and mean maxima of over 35 °C in January and/or February in some years (Figure 1).

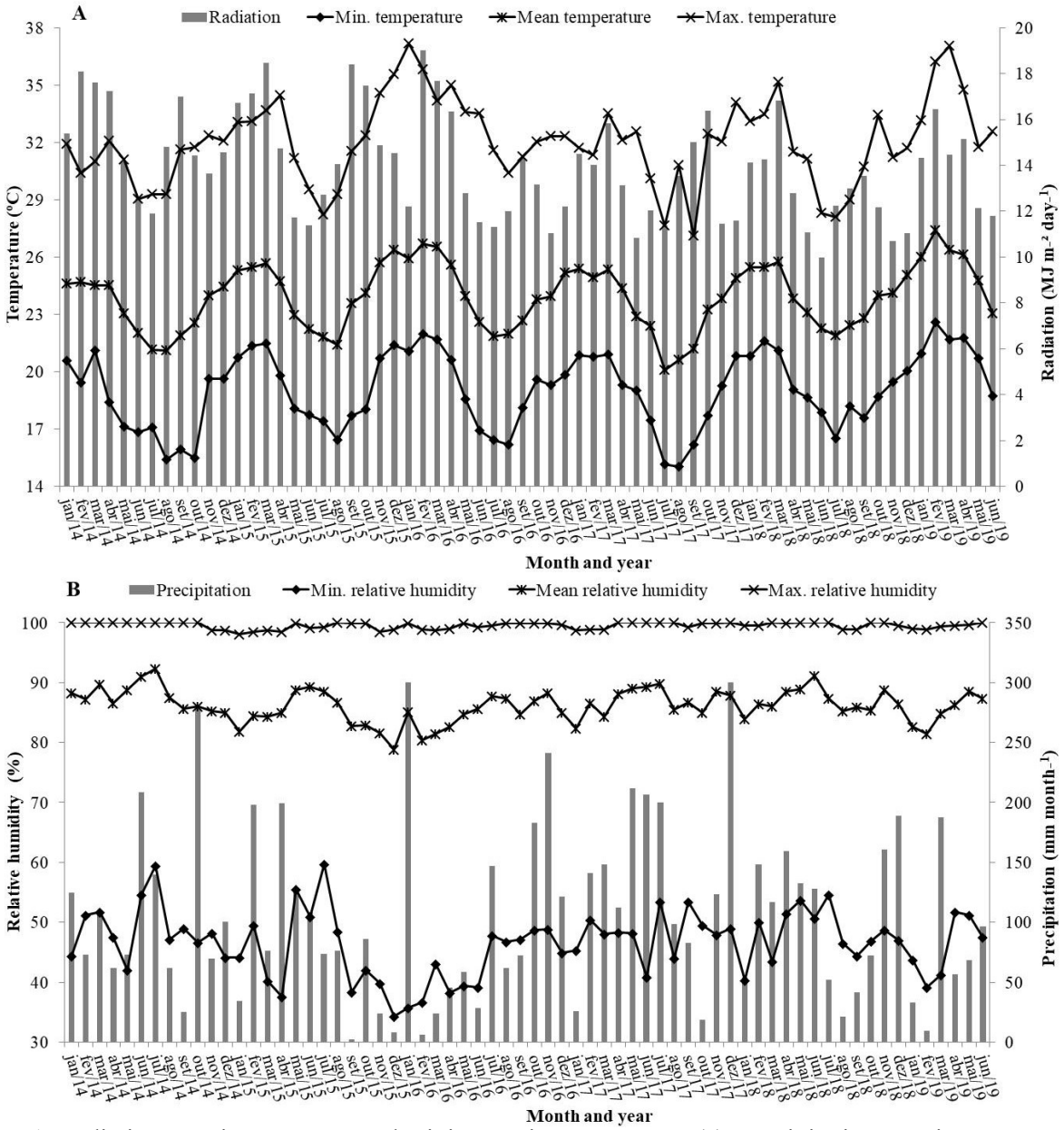

Figure 1. Radiation, maximum, mean and minimum air temperatures (a); Precipitation, maximum, mean and minimum relative humidity (b) in the experimental period from January 2014 to June 2019. Itabela – BA.

The genotypes were tested in a "competition trial", arranged in a randomized block design with three replications of seven plants each. The number of orthotropic branches was controlled by pruning, to maintain around 12,000 - 15,000 stalks per hectare. In all experimental years, mechanical and chemical weeding was performed at least once and insecticides and fungicides were applied. The experimental area was drip-irrigated in all evaluation years. Fertilizers (N, P_2O_5 and K_2O) were applied according to the plant requirements and phenological stages (600, 100 and 400 kg ha^{-1} $year^{-1}$, respectively).

The experimental plot was harvested four times in the study period (2016, 2017, 2018 and 2019), according to the maturation cycle of each genotype. The plots were harvested separately for each genotype, measuring the production in liters per plot. Later, the individual yield of each genotype was converted into bags of green coffee per hectare, based on two harvests and extrapolated to the others and, based on the plant spacing, yield per hectare was calculated.

Performance

Yield data of four harvests (2016, 2017, 2018 and 2019) were used to select the plant material for a competition assay (Table 1). Among all tested genotypes, the six best (AD1, AP, Imbigudinho, LB1, P2, Peneirão) were selected, based on traits such as yield, root system, maturation period and apparent plant vigor, to develop a new clonal cultivar named Monte Pascoal. The overall mean yield of the six genotypes in the four harvests was 130 bags ha^{-1} $year^{-1}$, while the mean of the other genotypes was lower than 95 bags ha^{-1} $year^{-1}$ (Table 1). The ratio of mature cherry to clean coffee yield of cv. Monte Pascoal was also higher than of the other assessed genotypes (Table 1).

For some leaf traits of the six genotypes (Table 2), high variation was observed in, e.g., distance between nodes of plagiotropic branches, leaf length, leaf width, leaf area, number of stomata, stomatal polar diameter, stomatal index, stomatal functionality, as well as of characteristics related to the root system within a distance of 30 cm from the plant and down to a depth of 60 cm.

The coffee growth and yield performance of the selected genotypes in the evaluated years indicated satisfactory adaptation to cultivation at 140m asl. No severe attacks of the main pests or diseases and no flowering/pollination problems were observed. Plant vigor and leafiness were continuously good, from the beginning to the end of the cycle. Where the cultivar was developed, the maturation of the six genotypes varied from early (AD1) to early/intermediate (Imbigudinho) and intermediate (AP, LB1, P2 and Peneirão), under the given soil-climatic conditions (Table 1).

Table 1. Yields of the 2016, 2017, 2018, 2019 growing seasons and mean yield, yield in liters of mature coffee necessary to obtain a 60 kg bag benefited and maturation period. Itabela - BA

Genotypes	Yield 2016	Yield 2017	Yield 2018	Yield 2019	Mean yield	Yield	Maturation
	bags ha-1	bags ha-1	bags ha-1	bags ha-1	bags ha-1	L bag-1	-
AD1	71.2	146.5	146.7	91.6	114.0	303	Early
AP	87.9	157.0	159.2	88.6	123.2	314	Medium
Imbigudinho	58.09	141.7	174.5	119.8	123.5	325	Early/ medium
LB1	98.9	193.2	177.2	104.2	143.4	312	Medium
P2	80.0	130.3	191.7	140.4	135.6	317	Medium
Peneirão	106.7	131.2	216.9	105.7	140.1	327	Medium
Mean of Cultivar Monte Pascoal					130.0a	316.2b	-
Mean of the other evaluated genotypes**					95.0b	352.6a	-

* Means followed by equal letters in a column do not differ by the Dunnett test, at 5% probability. ** 18, 122, 700, A1, Alecrim, B01, Bamburral, Beira Rio 8, Bicudo, CH1, Clementino, Cheique, Emcapa 02, Emcapa 143, Emcapa 153, Graudão HP, L80, Ouro Negro, Ouro Negro 1, Ouro Negro 2, P1, Pirata, Semente, Valcir P, Verdim D, Verdim R, Tardio C, Tardio V, Z18, Z21, Z29, Z35, Z36, Z37, Z38, Z39, Z40.

Table 2. Some main plant traits (branches, leaf and root system) of six genotypes of cultivar Monte Pascoal

Genotype	DBP cm	LL cm	LW cm	LA cm^{-2}	NS n. mm^{-2}
AD1	4.06a	13.37c	5.98c	51.01c	29.10b
AP	3.97a	12.40c	5.00d	38.96d	35.00a
Imbigudinho	3.42c	14.61b	6.04c	53.11c	24.80c
LB1	3.40c	14.54b	6.33c	59.42b	26.30c
P2	3.79b	15.96a	7.18a	75.80a	29.60b
Peneirão	3.86b	14.76b	6.39b	60.24b	29.50b
Mean	**3.75**	**14.27**	**6.15**	**56.42**	**29.05**

Genotype	PD µm	SI %	FUN -	SA 0-60 $cm^2\ dm^{-3}$	SA 0-20 %
AD1	25.20d	22.30b	1.47b	389.26c	55.28b
AP	25.30d	24.70a	1.53a	525.70b	41.04c
Imbigudinho	27.80a	21.10c	1.53a	562.29b	63.43a
LB1	27.00b	21.80c	1.49b	496.42b	74.17a
P2	26.50c	23.90a	1.56a	613.89a	64.25a
Peneirão	26.20c	22.00b	1.56a	472.77c	59.31b
Mean	**26.33**	**22.63**	**1.52**	**510.06**	**59.58**

DBP: Distance between nodes of plagiotropic branches; LL: Leaf length; LW: Leaf width; LA: Leaf area; NS: Number of stomata; PD: Stomatal polar diameter (µm); SI: Stomatal index; FUN: Stomatal functionality; AS 0-60: Surface area of the root system within a distance of 30 cm from the plant and down to a depth of 60 cm; SA 0-20% of surface area in the 0 - 20 cm soil layer, all parameters evaluated in Nova Venécia – ES. Means followed by equal letters in a column do not differ by the Scott-Knott test, at 5% probability.

Cultivar Monte Pascoal is recommended for cultivation at altitudes below 500 m asl in southern Bahia. For other studies in progress, data are being collected in analyses of the physiological and chemical grain characteristics, cup quality and anatomical and biochemical parameters of the genotypes. Most of the promising genotypes were initially identified by coffee farmers. Thus, the information about the origin of each genotype is recorded as follows:

AD1: Plant found by the farmer Ademir Trevizani, on a field of seed-derived plants in the county of Itabela, Southern of Bahia State. It was discovered on Mr. Trevizani's property around 2005 and then multiplied on the family's own plantations and in the region.

AP: Plant found by the farmer Adilson Pereira, on his own property, in the county of São Mateus, Northern of Espírito Santo State. The plant, now also known as Tecnoverde, was selected in 2002, on a seed-propagated plantation.

LB1: Selected in Sooretama by the greenhouse operator and rural producer Antonio Luiz Bachetti, popularly known as Tonin Bachetti.

P2: Genotype selected by the coffee grower Paulo Benacchi, in the county of Marilândia - ES.

Imbigudinho: Plant found by farmer José Américo Moraes (known as Mequinho) on his property, around 2008, in Parajú, county of Vila Valério - ES. Later, the genotype was reproduced and propagated in the region by Mr. Roque Lane Rosa.

Peneirão: Genotype found by farmer Gerson Cosme on his property in Giral, county of Jaguaré - ES. He found 22 identical cutting-propagated plants, on an organically managed field. The clone seedlings of the plantation had been purchased from the greenhouse operator Alercio Marinato - Jaguaré. As of 2010, the plant began to be cultivated on a larger scale by the farmer himself and by other coffee growers of the region.

Clone maintenance and distribution

Cultivar Monte Pascoal was registered in 2020, by the National Registry of Cultivars (*Registro Nacional de Cultivares*, RNC) by the Brazilian Ministry of Agriculture, Livestock and

Food Supply (*Ministério da Agricultura, Pecuária e Abastecimento*), as no. 44082. The Federal University of Espírito Santo (UFES) is in charge of maintaining the six genotypes that constitute cv Monte Pascoal.

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