CROP BREEDING AND APPLIED BIOTECHNOLOGY

CULTIVAR RELEASE

Tributun: a coffee cultivar developed in partnership with farmers

Crop Breeding and Applied Biotechnology
20(2): e30002025, 2020
Brazilian Society of Plant Breeding.
Printed in Brazil
http://dx.doi.org/10.1590/1984-70332020v20n1c21

Fábio Luiz Partelli[1*], João Antonio Dutra Giles[1], Gleison Oliosi[1], André Monzoli Covre[1], Adésio Ferreira[2] and Valcir Meneguelli Rodrigues[3]

Abstract: *Tributun is a cultivar of Coffea canephora derived from breeding clones discovered by farmers. It was evaluated at 150 m asl in northern Espírito Santo for yield, plant vigor and pest and disease resistance. The cultivar with six genotypes produces a mean yield of 90.87 bags ha^{-1} year^{-1}.*

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

INTRODUCTION

Around 174 million bags of coffee are produced annually worldwide. Of this total output, 59.8% is coffee of the species Arabica (*Coffea arabica*) and 40.2% of Robusta/Conilon (*C. canephora*) (https://www.fas.usda.gov/data/coffee-world-markets-and-trade). The entire coffee chain produces an annual revenue of around 173,000 million U$D (ICO 2019), whereas Brazil accounts for approximately 32% of the global output (http://www.conab.gov.br). In view of the predicted population growth and climatic changes, more efforts should be invested in raising coffee yields and quality by sustainable and environmentally responsible actions.

Conilon coffee is a self-sterile, diploid and, in view of the gametophytic self-incompatibility, allogamous plant. In vegetatively propagated plants, the mother plant traits are maintained by inheritance, ensuring uniform crop development, higher yields, better fruit quality and the possibility of selecting varieties with different maturation cycles (Partelli et al. 2014b, Partelli et al. 2019).

Coffea canephora tolerates temperatures up to 37 ºC by the maintenance or intensification of photoprotection 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 delayed (Partelli et al. 2010, Covre et al. 2016). In the latter case, heat can affect the plant physical characteristics, reducing grain weight and yield (Ramalho et al. 2018). A possibility of mitigating the thermal stress is to grow coffee under the shade of other trees (Partelli et al. 2014a, Oliosi et al. 2016).

Some tolerance characteristics were observed at the field scale, at low and high temperatures and under water stress, varying according to the *Coffea* genotypes (Covre et al. 2016, Gomes et al. 2016, Bonomo et al. 2017, Dubberstein et al. 2017, Giles et al. 2019, Partelli et al. 2019).

***Corresponding author:**
E-mail: partelli@yahoo.com.br
ORCID: 0000-0002-8830-0846

Received: 21 November 2019
Accepted: 10 January 2020
Published: 24 March 2020

[1] Universidade Federal Espírito Santo, 29.932-540, São Mateus, ES, Brazil
[2] Universidade Federal Espírito Santo, 29.500-000, Alegre, ES, Brazil
[3] Farmer, 29.785-000 Vila Valério, ES, Brazil

Regarding the suitability, Tributun is a *C. canephora* cultivar indicated for cultivation at low altitudes. The six genotypes were field- tested at 150 m asl and registered by the Brazilian Ministry of Agriculture, Livestock and Food Supply (MAPA) (http://sistemas.agricultura.gov.br/snpc/cultivarweb/cultivares_registradas.php).

BREEDING PROCESS

A group of 30 promising *C. canephora* genotypes (29 cutting- and one seed-propagated) was selected, propagated by cuttings and planted in an experimental plot. Selection targeted high yield potential and agronomic traits of interest, most of which had been selected by coffee farmers in the State of Espírito Santo. The experimental plot was planted in May 2012, at a spacing of 2.7 m x 1.2 m, totaling 3086 plants ha^{-1}, in the county of Vila Valério, Espírito Santo, Brazil, (lat 18° 58′ 05.00" S, long 40° 20′ 02.00" W, alt 150 m asl), where the average annual temperature is 23 °C. According to Köppen, the regional climate is Aw tropical, characterized by hot humid summers and dry winters (Alvares et al. 2013), with an average annual precipitation of 1,200 mm. The entire experimental plot was sprinkler-irrigated and the treatments arranged in a completely randomized block design with four replications, in which the different genotypes represented the treatments and each experimental unit contained four coffee plants.

In terms of management practices, weed control was performed by mechanical and chemical means and the plot was fertigated, while no micronutrients, insecticide or fungicide were applied in the study period. According to the plant requirements and phenological stages, the treatments were fertilized with N, P_2O_5 and K_2O, respectively, at 500, 100 and 400 kg ha^{-1} $year^{-1}$.

The experimental plot was harvested four times in the study period (2014, 2015, 2016 and 2017), according to the maturation cycle of each genotype. Coffee yield was measured in liters per plot and later converted into bags of processed coffee per hectare, where 320 L equals one 60 kg bag of processed coffee (Barbosa et al. 2014, Oliosi et al. 2016) and, based on the plant spacing, yield per hectare was calculated.

PERFORMANCE

Yield data of the four harvests (2014, 2015, 2016 and 2017) were used for the competition assay and selection of the plant material (Table 1). Among all tested genotypes, six superior genotypes (A1, Bambural, Beira Rio 8, Clementino, Pirata and Verdim R) were selected, based on traits such as yield and apparent plant vigor, to develop a new clonal cultivar, named Tributun. The mean yield of the six genotypes across the four harvests was 90.87 bags ha^{-1} $year^{-1}$ (Table 1). This mean yield might seem modest, but may have been reduced by the severe drought of 2015 and 2016 (Table 1). In addition, although apparently moderate, the yield of cv Tributun was far higher than the average Conilon coffee yield in Brazil (http://www.conab.gov.br).

With regard to the plant traits, evaluated after 477 days, the genotypes had a plant height of 76.94 to 88.56 cm, crown diameter of 108.56 to 147.88 cm, internode length of 2.95 to 3.99 cm, fruit weight of 0.834 to 1.413 g and fruit volume of 0.852 to 1.350 mL (Table 1).

Table 1. Plant height and diameter 477 days after planting, plagiotropic branch node length, mature fruit weight and volume, mean yield of four harvests (2014, 2015, 2016 and 2017) and maturation

Genotypes	Height	Diameter	Internode	Weight	Volume	Yield	Maturation
	(cm)	(cm)	(cm)	(g)	(mL)	(bags ha^{-1})	-
A1	76.94	115.81	3.66	1.091	1.060	87.03	Medium
Bambural	86.00	110.75	2.95	0.928	0.900	88.56	Medium/late
Beira Rio 8	84.75	110.50	3.54	1.413	1.350	82.72	Early/medium
Clementino	88.56	126.00	3.48	1.046	0.990	82.52	Medium
Pirata	87.50	147.88	3.91	1.073	0.977	105.78	Early
Verdim R[1]	82.38	108.56	3.10	0.834	0.852	98.60	Early/medium
Mean	84.36 a	119.92 a	3.44 a	1.06 a	1.02 a	90.87 a	
Mean (Emcapa[2])	67.85 b	95.00 b	2.78 b	0.932 a	0.935 a	78.66 b	Medium/late

* Means followed by equal letters in a column do not differ by the Dunnett test, at 5% probability. [1] Yield (mature cherry: processed coffee) is usually lower;
[2] These genotypes (Mean Emcapa 143 and 153) are not part of the new cultivar, but were included in the competition test for means of comparison.

Table 2. Means of 10 leaf morpho-anatomical traits of six genotypes of cultivar Tributun

Genotype	SN	SI	SD	SAI	PD	ED	FUN	LA	DW	SDW
A1	17.00c	20.67c	155.78b	400.58a	23.50a	17.03a	1.39b	63.81a	774.53a	12.22a
Bambural	24.38b	22.25b	223.36a	337.50b	21.14b	15.89a	1.34b	56.09a	708.49a	13.08a
Beira Rio 8	25.63a	23.31b	234.82a	350.08a	21.46a	16.14a	1.30b	52.14b	665.47a	13.04a
Clementino	28.25a	25.87a	258.87a	394.62a	23.69a	16.63a	1.44a	58.52a	880.69a	15.48a
Pirata	19.75c	23.23b	180.98b	367.80a	22.39a	16.76a	1.38b	59.29a	628.69a	10.72b
Verdim R	17.00c	20.27c	155.78b	374.83a	22.72a	16.40a	1.40b	50.91b	619.56a	12.30a
Mean	21.75	22.35	267.50	359.56	22.17	15.82	1.41	55.55	669.83	12.12

SN: Stomatal number; SI: Stomatal index (%); SD: Stomatal density (number of stomata. mm^{-2}); SAI: Stomatal area index (μm^2); PD: Stomatal polar diameter (µm); ED: Stomatal equatorial diameter (µm); FUN: Stomatal functionality; LA: Leaf area (cm^2); DW: Dry weight (mg); SDW: Specific dry weight (mg cm^{-2}). Means followed by equal letters, in a column, do not differ by the Scott-Knott test, at 5% probability. Data according to Giles et al. (2019).

The evaluation of the six genotypes (Table 2) showed a great variation in some leaf traits, i.e., stomatal number and density. For other traits, i.e., stomatal index, stomatal polar diameter, stomatal equatorial diameter and stomatal functionality, the variation among the six genotypes was low.

The coffee growth and yield performance of the selected genotypes in the evaluated years indicated satisfactory adaptation to the cultivation conditions at 150 m asl. No severe attacks of the main pests or diseases and no flowering/pollination problems were observed. The plant vigor and leafiness were continuously good throughout the cycle. Under the soil-climatic conditions where the cultivar was developed, the maturation of the six genotypes varied from early (Pirata) to early/intermediate (Beira Rio 8 and Verdim R) and intermediate (Bambural, Clementino and A1) maturation (Table 1).

Cultivar Tributun is recommended for cultivation in areas lower than 500 m asl in Espírito Santo, southern Bahia and eastern Minas Gerais. Other studies, involving physiological, anatomical and biochemical analyses of the genotypes, are currently in progress.

Most of the promising genotypes were “discovered” by farmers. Thus, the initial information of each genotype is recorded as follows:

A1: Genotype initially propagated by Ivan Milanez and Hélio Dadalto, also known as H and H1.

Bambural: Genotype discovered and propagated by José Bonomo in the late 1980s. Superior plant found in the county of São Mateus, on a farm owned by Eliseu Bonomo.

Beira Rio 8: Initially, several plants found on a field near the Rio São José in the county of Rio Bananal, were selected and multiplied by the coffee farmers José Francisco Partelli and Valcir Meneguelli Rodrigues. After some harvests on a commercial field in Vila Valério, Valcir M. Rodrigues pre-selected six clones that were tested in a competition trial, and the clone named Beira Rio 8 was selected.

Clementino: For three years, the coffee farmer Valcir Meneguelli Rodrigues observed a coffee tree with superior performance near the roadside in the county of Vila Valério. The plant belonged to another coffee farmer, Clementino Figueira de Barros.

Pirata (also known as **24**): Plant discovered by Paulo Renato Pimenta Maia, on his farm in Córrego da Areia, São Mateus, in the late 1990s. It was multiplied and propagated by Fausto Afonso Cremasco.

Verdim R: Clone of uncertain origin. Its superior performance was observed when grown on the farm of José Valiatti, in the county of Jaguaré, and was initially multiplied by Jailson Antonio do Nacimento.

CLONE MAINTENANCE AND DISTRIBUTION

Cultivar Tributun was registered as no. 37808 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*). The Federal University of Espírito Santo (UFES) is responsible for the maintenance of the six genotypes that constitute cv Tributun.

ACKNOWLEDGMENTS

The authors wish to thank the first breeders, i.e., the coffee farmers, who initiated the selection of most of the superior genotypes available nowadays. Thus, the names of the clones were maintained as they are known among coffee growers. We are also indebted to the Federal University of Espírito Santo (UFES) for supporting this study; the Foundation for Research and Innovation Support of Espírito Santo (FAPES) and the National Council of Scientific and Technological Development (CNPq) for the financial support.

REFERENCES

Alvares CA, Stape JL, Sentelhas PC, Gonçalves JLM and Sparovek G (2013) Köppen's climate classification map for Brazil. **Meteorologische Zeitschrift 22**: 711-728.

Barbosa D, Rodrigues W, Vieira H, Partelli F and Viana A (2014) Adaptability and stability of Conilon coffee in areas of high altitude. **Genetics and Molecular Research 13**: 7879-7888.

Bonomo DZ, Bonomo R, Partelli FL and Souza JM (2017) Performance of Conilon coffee genotypes under different adjusted crop coefficients. **IRRIGA 22**: 236-248.

Covre AM, Partelli FL, Bonomo R, Braun H and Ronchi CP (2016) Vegetative growth of Conilon coffee plants under two water conditions in the Atlantic region of Bahia State, Brazil. **Acta Scientiarum. Agronomy 38**: 535-545.

Dubberstein D, Partelli FL, Machado Dias JR and Espindula MC (2017) Influence of fertilization on coffee trees vegetative growth in west south Amazon. **Coffee Science 12**: 50-59.

Giles JAD, Ferreira AD, Partelli FL, Aoyama EM, Ramalho JC, Ferreira A and Falqueto AR (2019) Divergence and genetic parameters between *Coffea* sp. genotypes based in foliar morpho-anatomical traits. **Scientia Horticulturae 245**: 231-236.

Gomes WR, Rodrigues WP, Vieira HD, Oliveira MG, Dias JRM and Partelli FL (2016) Genetic diversity of standard leaf nutrients in *Coffea canephora* genotypes during phenological phases. **Genetics and Molecular Research: 15**: gmr.15048839.

ICO - International Coffee Organization (2019) **Global coffee trade**. Available at <http://www.ico.org/trade_statistics.asp>. Accessed on July 18, 2019.

Martins MQ, Rodrigues WP, Fortunato AS, Leitão AE, Rodrigues AP, Pais IP, Martins LD, Silva MJ, Reboredo FH, Partelli FL, Campostrini E, Tomaz MA, Scotti-Campos P, Ribeiro-Barros AI, Lidon FJC, Damatta FM and Ramalho JC (2016) Protective response mechanisms to heat stress in interaction with high [CO2] conditions in *Coffea* spp. **Frontiers in Plant Science 7**: 947.

Oliosi G, Giles JAD, Rodrigues WP, Ramalho JC and Partelli FL (2016) Microclimate and development of *Coffea canephora* cv. Conilon under different shading levels promoted by Australian cedar (Toona ciliata M. Roem. var. Australis). **Australian Journal of Crop Science 10**: 528-538.

Partelli FL, Araújo AV, Vieira HD, Dias JRM, Menezes LFT de, Ramalho JC, Partelli FL, Araújo AV, Vieira HD, Dias JRM, Menezes LFT de and Ramalho JC (2014a) Microclimate and development of "Conilon" coffee intercropped with rubber trees. **Pesquisa Agropecuária Brasileira 49**: 872-881.

Partelli FL, Covre AM, Oliveira MG, Alexandre RS, da Vitória EL and da Silva MB (2014b) Root system distribution and yield of "Conilon" coffee propagated by seeds or cuttings. **Pesquisa Agropecuaria Brasileira 49**: 349-355.

Partelli FL, Golynski A, Ferreira A, Martins MQ, Mauri AL, Ramalho JC and Vieira HD (2019) Andina - first clonal cultivar of high-altitude conilon coffee. **Crop Breeding and Applied Biotechnology 19**: 476-480.

Partelli FL, Vieira HD, Silva MG and Ramalho JC (2010) Seasonal vegetative growth of different age branches of conilon coffee tree. **Semina:Ciencias Agrarias 31**: 619-626.

Ramalho JC, Rodrigues AP, Lidon FC, Marques LMC, Leitão AE, Fortunato AS, Pais IP, Silva MJ, Scotti-Campos P, Lopes A, Reboredo FH and Ribeiro-Barros AI (2018) Stress cross-response of the antioxidative system promoted by superimposed drought and cold conditions in *Coffea* spp. **PLoS ONE 13**: e0198694.

Rodrigues WP, Martins MQ, Fortunato AS, Rodrigues AP, Semedo JN, Simões-Costa MC, Pais IP, Leitão AE, Colwell F, Goulao L, Máguas C, Maia R, Partelli FL, Campostrini E, Scotti-Campos P, Ribeiro-Barros AI, Lidon FC, DaMatta FM and Ramalho JC (2016) Long-term elevated air [CO2] strengthens photosynthetic functioning and mitigates the impact of supra-optimal temperatures in tropical *Coffea arabica* and *C. canephora* species. **Global Change Biology 22**: 415-31.