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MGS Aranãs: the new Arabica coffee cultivar developed by Epamig with wide adaptation

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ABSTRACT

This paper describes the MGS Aranãs cultivar (H32-11-17-4-2-MS-MS) resulting from a cross between the cultivars Icatu 3851-2 and Catimor. The MGS Aranãs cultivar is characterized by small size, ripe red fruits, large seeds, coffee leaf rust resistance, an architecture suitable for densification, production stability, and high beverage quality. This new cultivar is recommended for the Sul de Minas, Cerrado Mineiro and Vale do Jequitinhonha regions.

Key words: Sustainability; Coffee leaf rust; Beverage quality; Minas Gerais state.

1 INTRODUCTION

Breeding for disease resistance in combination with vigor, yield and coffee-beverage quality has contributed to development of Brazilian coffee crop. Limiting factors of coffee production include diseases such as coffee leaf rust (or orange rust) caused by the fungi *Hemileia vastatrix* Berk. et. Br (Talhinhas et al., 2017). Sources of resistance identified in coffee species have been used for interspecific hybridization to obtain resistant plants that possess relevant agronomic characters. These disease-resistant cultivars have been contributing considerably to ecologically sustainable coffee production and to socio-economic benefits for the growers of Arabica coffee (Van der Vossen; Bertrand; Charrier, 2015).

Due to large variability that occurs in *H. vastatrix* fungus, there are new physiological races with genes of virulence capable of nullifying the resistance of cultivars, especially in ecosystems very favorable to pathogen. Breakdowns of resistance have had the consequence of forcing breeders to develop new cultivars with durable resistance to the disease. One procedure is the pyramiding or the accumulation of several major resistance genes in a single cultivar (Ghuge; Mirza, 2021). It is more difficult for the pathogen to overcome multiple resistance genes as it requires the loss or masking of its complementary avirulence genes (Avelino et al., 2015).

The main source of genes for resistance to all races of *H. vastatrix* is currently the 'Timor Hybrid', a germplasm derived from a spontaneous crossing of *Coffea arabica* L. and *Coffea canephora* Pierre ex A. Froehner (Eskes et al., 1990). The known major genes that confer rust resistance are SH_1 to SH_9. The SH_6, SH_7, SH_8 and SH_9 are derived from *C. canephora*, one of the parents of 'Timor Hybrid' and from other interspecific hybrids such as 'Icatu'. Several 'Timor Hybrid' plants have at least the genes SH_5 to SH_9 (Shigueoka et al., 2014). This strategy has been used by the *Empresa de Pesquisa Agropecuária de Minas Gerais* (Agricultural Research Company of Minas Gerais, EPAMIG), in coffee breeding program. In the early 1970's, 'Catimores', rust-resistant varieties from Coffee Rust Research Center (CIFC), in Oeiras, Portugal, were introduced into Brazil (Zambolim, 2016).

Since its creation in 1972, the EPAMIG has contributed to development, release, adaptation and implementation of new cultivation and management technologies. Our primary focus has been the development of coffee varieties with high yield, rust resistance and a chemical composition with greater potential for high-value beverages. In this context, MGS Aranãs was produced from an artificial cross between Icatu germplasm coffee and Catimor. The name Aranãs was given in honor of an indigenous community in Vale do Jequitinhonha (a region of the Minas Gerais state, Brazil), of which many members are employed on farms in the region.

2 MATERIAL AND METHODS

The cultivar MGS Aranãs was derived from an artificial cross between Icatu 3851-2 (UFV 2177) progeny and a selected Catimor cultivar (1509-c8); the two parent plants were donors of genes that confer resistance to *H. vastatrix*. This cultivar was developed in the regions of Sul de Minas (Southern Minas; São Sebastião do Paraíso, Machado and Três Pontas), Cerrado Mineiro (Campos Altos) and Vale do Mucuri (Aricanduva). The edaphoclimatic characteristics of these sites where are describe in Table 1.

The Icatu 3851-2 (UFV 2177) progeny were identified at the Experimental Field of Epamig in São Sebastião do Paraíso (CESP), MG, Brazil, as 274, originating from plant 16. For the cross, pollen was used from hill 21 of replicate 2 of the Icatu progeny competition experiment conducted at CESP. The UFV 5373 access originated from the UFV 1603-215 EP20.5 coffee tree and was introduced at CESP by designation Catimor 1509; hill 8 was selected for the crossbreeding.

The hybrid seeds were obtained in 1986, and the pedigree method was used in the breeding process. The hybrid derived from this cross was registered as H32. The second generation (F_2) was obtained from hill 11 in January 1987 and grown at CESP under the designation H32-11.

In March 1992, hill 17 was selected and produced the F_3 generation, which is still present at the CESP. Plants from the F_4 generation were selected from hill 4 and established in February 1999 at CESP; at Experimental Fields of Epamig in Três Pontas municipality (CETP), at Machado municipality (CEMA) and at Ouro Verde Farm, a private property in municipality of Campos Altos. The progeny of these plants were studied in another CESP trial, and the F_5 generation was established in January 2003.

In March 2009, the F_5 generation was established in the municipality of Aricanduva, MG, and was obtained by combining the seeds from several plants. From these progeny, another mixture of seeds from selected plants was evaluated in multiplication and selection field in the municipality São Gonçalo do Sapucaí, in Minas Gerais state, Brazil. The plants in this field constituted the H32-11-17-4-2-MS-MS progeny in generation F_6 that were designated as MGS Aranãs cultivar. Another experiment was implemented in 2011 in the Municipality of Araxa. The seed production field was established in 2014 in Três Pontas. The productivity results of these four municipalities are presented in Table 2. The experiments implemented in Araxa and Aricanduva were submitted to statistical analyses using the software 'Sisvar' (Ferreira, 2014). The means of the yield (bags ha^{-1}) were compared by Student t-test.

3 RESULTS

The MGS Aranãs cultivar was developed in Dystrophic Red Latosol (Oxisol) and Cambisol, in relief undulating, slightly undulating, strongly undulating and also flat mountainous (Tabel 1). It is adapted to the major coffee-producing regions of Minas Gerais and other Brazilian states that are suitable for *C. arabica* and can be grown in regions with an average annual temperature between 17 and 21 ºC, elevation between 890 m and 1230 m, and 1470 mm and average annual rainfall around 1830 mm.

The mean yield of the first eight harvests, generation F_5, in the municipality of Aricanduva was 44 bags (60 kg/bag) of wet-processed coffee per hectare (Table 2). In São Gonçalo do Sapucaí the yield was 40 bags of wet-processed

Table 1: Edaphoclimatic characteristics of experimental sites where the cultivar MGS Aranãs originated.

Characteristic	Três Pontas	São Sebastião do Paraíso	Machado	Campos Altos	Aricanduva
Type of soil	Dystrophic Red Latosol (Oxisol)	Dystroferric Red Latosol (Oxisol)	Cambisol	Dystrophic Red Latosol (Oxisol)	Dystroferric Red Latosol (Oxisol)
Texture	Clayey	Clayey	Clayey	Clayey	
Relief	Undulating	Slightly undulating	Strongly undulating	Flat	Mountainous
Elevation	900 m	890 m	960 m	1230 m	
Average annual rainfall	1670 mm	1470 mm	1670 mm	1830 mm	1081 mm
Average annual temperature	20.1 °C	20.8 °C	19.8 °C	17.6 °C	20.1 °C

Table 2: Mean yield (bags ha^{-1}) of the MGS Aranãs cultivar in the municipalities of Aricanduva (AR), São Gonçalo do Sapucaí (SGS), Araxá (AX), and Três Pontas (TP).

Cultivar	AR[1]	SGS[2]	AX[3]	TP[4]
MGS Aranãs	44.0a	40.0	60.00a	44.6
Catuaí Vermelho IAC 144	35.8b	-	54.3b	-

[1]Mean of the first eight harvests (2010/2011 to 2017/2018), F_5 generation, at 3.6 x 0.7 m spacing; [2]mean of the first five harvests (2014/2015 to 2018/2019) , F_6 generation, at 3.6 m x 0.8 m spacing;[3]mean of three harvests (2013/2014 to 2015/2016), F_7 generation, at 3.5 x 0.7 spacing, [4]mean of two harvests (2017/2018 to 2018/2019), F_8 generation, at 3.2 x 0.7 spacing. Means followed by the same letter do not differ by Student-t test (P <0.05).

coffee per hectare. In municipality of Araxá, the mean yield of the cultivar was 60 bags for three harvests, and in Três Pontas the yield was 44.6 bags of wet-processed coffee per hectare. It is important to note that the plants of the MGS Aranãs group were managed without any type of phytosanitary control for pests and diseases, except for the control of the coffee borer beetle, whereas the Catuaí Vermelho IAC 144 cultivar received the recommended chemical treatments for the control of coffee rust. Morpho-agronomic traits of MGS Aranãs coffee cultivar are showed in Table 3.

Table 3: Morpho-agronomic traits of MGS Aranãs coffee cultivar.

Plant height (Size):	Low
Crown shape:	Conical
Crown diameter:	Medium
Internode length:	Short
Secondary branching:	High
Color of leaves (shoots):	Light bronze (when young) and green (when adults),
Leaf size:	Medium
Color of ripe fruit:	Red
Fruit shape:	Oblong
Seed size:	Medium to large
Seed shape:	Wide
Maturation cycle:	Medium
Leaf blade edges:	Slightly undulate
Rust resistance:	High
Vegetative Vigor:	High
Beverage quality:	Superior and differentiated
Yield:	High production potential

4 DISCUSSION

The mean yield of the cultivar MGS Aranãs is comparable to the traditional Catuaí Vermelho IAC 144 cultivar in the municipalities studied (Table 2), demonstrating the high adaptability of this cultivar to the coffee-producing regions of Minas Gerais.

At eight years old, coffee plants of MGS Aranãs cultivar are small with an average height of 2.7 m and a mean stem diameter of 6.65 cm. The plants have a cone-shaped architecture with a mean crown diameter of 2.10 m and plagiotropic branches with short internodes and abundant secondary branches. The ripe fruits are red, and the seeds are large (Table 3). The new leaves are a light bronze color and leaves are bright dark green when mature. The recommended plant spacing ranges from 0.60 to 0.8 m depending on the cultivation site and the technologies used.

The cup quality of disease-resistant cultivars issued from Arabica coffee breeding programmes will have to be comparable to that of best traditional varieties to ensure market acceptance (Van der Vossen; Bertrand; Charrier, 2015). In preliminary tests for cup quality, a sensory analysis of the cultivar MGS Aranãs based on the classification criteria recommended by the Brazil Specialty Coffee Association (BSCA) showed excellent potential with a score of 88 points, dried fruit (apricot) notes, good body and a pleasant finish. As one of its primary traits, the cultivar MGS Aranãs also has medium to large beans, such that 70% of the beans can pass through a sieves larger than 17/64″.

This cultivar shows vertical resistance to rust (Silva et al, 2020), and this resistance could be compromised if new physiological races of the pathogen *H. vastatrix* emerge. Due to its potentially high yield, particularly in the initial production cycles, this cultivar may exhibit deficiencies if the coffee plants are not properly nourished.

The use of MGS Aranãs results in lower costs, as the resistance to rust allows coffee farmers to perform only one application of pesticide or to use protective fungicides alone, thus releasing fewer chemicals into the environment. Significant contributions can be expected through this new cultivar to improve the durability of coffee resistance to rust leaf disease, that results in the development of a sustainable coffee economy.

The cultivar MGS Aranãs is registered by the Registro Nacional de Cultivares (National Cultivars Registry, RNC) of the Brazilian Ministry of Agriculture, Livestock and Supply (MAPA) under number 33348. EPAMIG is responsible for the maintaining the genetic material (seeds).

5 CONCLUSION

The MGS Aranãs cultivar is recommended for the Sul de Minas, Cerrado Mineiro, and Vale do Jequitinhonha regions.

6 AUTHORS CONTRIBUTIONS

CEB, JCR, AAP, ACBO, GRC, and ADF participated of cultivar development (crossing and selection for the advancement of generations). CEB, and JCR wrote the manuscript. AAP, ACBO, GRC, and ADF review and approved the final version of the work.

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