CROP BREEDING AND APPLIED BIOTECHNOLOGY

CULTIVAR RELEASE

MGS Guaiçara and MGS Vereda: *Coffea arabica* cultivars resistant to the root-knot nematode *Meloidogyne paranaensis*

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Abstract: *MGS Guaiçara e MGS Vereda are resistant to Meloidogyne paranaensis, one of the most aggressive nematode parasites of coffee. MGS Vereda is an early maturation cultivar, whereas MGS Guaiçara has a medium maturation cycle. Both cultivars produce red fruit, have high size, and high yield potential in infested areas.*

Keywords: *Coffee, genetic resistance, M. paranaensis*

INTRODUCTION

In recent years, extensive occurrence of the *Meloidogyne paranaensis* nematode has been observed in the main coffee-producing regions in Brazil (Villain et al. 2018, Terra et al. 2019). This will predictably affect the sustainability and survival of coffee fields, as most *Coffea arabica* cultivars are susceptible to this phytopathogen that attacks the plant root system (Carneiro et al. 1996) and often leads to the death of susceptible coffee trees (Sera et al. 2020).

The last survey concerning nematode occurrence in coffee fields across the state of Minas Gerais was performed in 2008. At that time, the presence of *M. paranaensis* was restricted to three municipalities. Recently, this nematode has spread widely across coffee areas; it has been identified in six municipalities of the south of Minas and in seven in the *Cerrado Mineiro* region, just in 2018 (Terra et al. 2019).

The use of resistant cultivars for regeneration or establishment of coffee areas in infested regions not only contributes to the maintenance of coffee activity, which generates income and employment, but also prevents dissemination of the nematode by hindering its multiplication. Use of resistant cultivars also reduces environmental and health concerns, such as contamination caused by misuse of nematicides and exposure of workers to toxic products.

Currently, there are only two *C. arabica* cultivars resistant to *M. paranaensis* registered in Brazil: IPR 100 (Sera et al. 2017) and IPR 106 (Sera et al. 2020).

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Because of the recent increase in the *M. paranaensis* population in Brazil, the importance of commodity coffee for Brazil, and the limited availability of cultivars resistant to this pathogen, the Empresa de Pesquisa Agropecuária de Minas Gerais (EPAMIG) hereby presents the characteristics of the MGS Vereda and MGS Guaiçara cultivars of *C. arabica,* two new options for genetic control of *M. paranaensis*.

BREEDING HISTORY AND METHODS

Seedlings of Amphillo – a variety of *C. arabica* mainly cultivated in Ethiopia (Anthony et al. 2001) – were introduced in Brazil by the Instituto Agronômico (IAC) in 1953, when an experiment was carried out to evaluate their general characteristics. The result of this evaluation was selection of IAC 1167-19, as it exhibited desirable agronomic traits. Later, in the 1970s, several parameters of progenies of IAC 1167-19 were studied.

After field and greenhouse evaluations in the region of Adamantina, SP, seeds from plants resistant to *M. incognita* were selected and sent to the Instituto Brasileiro do Café (IBC) in Maringá, PR. Trials using these seeds/plants were then conducted in areas infested with *M. incognita*. In the S_2 generation of IAC 1167-19, IBC researchers selected and used the coffee plants MR 2-161 and MR 2-474 in crosses with the Catuaí Vermelho cultivar (without registering the line). The respective progenies in the F_3 generation were sent to several institutions: IAC, EPAMIG, the Instituto Agronômico do Paraná, the Universidade Estadual de Londrina, and the Universidade Estadual de Maringá.

In 2004, F_3 progenies from the crosses Catuaí Vermelho × Amphillo MR 2-161 and Catuaí Vermelho × Amphillo MR 2-474 were introduced into the EPAMIG Coffee Active Germplasm Bank (Banco Ativo de Germoplasma - BAG) in the Experimental Field of Patrocínio, MG, designated as MG 0179 and MG 0185, respectively. In 2009, the F_4 generation of these accessions was used in an experimental arrangement in an area infested with *M. paranaensis* (esterase phenotype P_1, Santos et al. 2020) on a private farm in the municipality of Piumhi, MG. Plants were selected based on the genealogical method. The lines 16-6-I, a descendant of MG 0179-1-R1, and 29-2-I, a descendant of MG 0185-2-R2, and others, were indicated as promising material according to assessments concerning first fruit production, vegetative vigor, and likely resistance to *M. paranaensis* (Salgado et al. 2014). Progenies of these lines, in the F_5 generation, were used in another experiment containing *M. paranaensis* set up on the same property.

In this selection cycle, the selected plants (16-6-I-10-7-II and 29-2-I-11-7-II) showed suitable performance regarding resistance to *M. paranaensis* and better agronomic performance and yield than the check cultivar (Catuaí Amarelo IAC 62) (Table 1). Resistance to *M. paranaensis* under controlled conditions was confirmed by Peres et al. (2017). In a third experiment, on the same property and under the same general conditions, MGS Guaiçara (progeny MG 0179-1-R1-16-6-I-10-7-II) and MGS Vereda (progeny MG 0185-2-R2-29-2-I-11-7-II) arose in the F_7 generation.

AGRONOMIC TRAITS

Agronomic traits were evaluated in the F_6 generation. Seven-year-old MGS Vereda coffee trees have an average height of 3.20 m and average stem diameter of 67.95 mm. The plants have a conical-shaped architecture, with a diameter of 2.23 m in the lower third of the canopy and 2.16 m in the middle third. The plagiotropic branches have long internodes, with abundant secondary branching. Seven-year-old coffee trees of the MGS Guaiçara cultivar have an average height of 2.95 m and average stem diameter of 78.09 mm. The plants have a high size, conical-shaped architecture, with a diameter of 2.06 m in the lower third of the canopy and 2.16 m in the middle third. Both cultivars have plagiotropic branches with long internodes and abundant secondary branching, red fruit, medium-size seeds, and green fully expanded leaves. Other morphoagronomic characteristics of the F_6 generation that gave rise to the MGS Guaiçara and MGS Vereda cultivars are presented in Table 2.

YIELD

The yields of the new cultivars MGS Guaiçara and MGS Vereda were evaluated based on data from the F_6 generation in an experiment set up in Piumhi, MG. Combined analysis of variance was performed on the data using Sisvar version 5.6 software (Ferreira 2014); the Scott-Knott test was applied for grouping means when significance was determined by the F test ($p < 0.05$). MGS Guaiçara and MGS Vereda had higher yield than the susceptible Catuaí Amarelo IAC 62 cultivar (Table 1).

RESISTANCE TO *MELOIDOGYNE PARANAENSIS*

The population of *M. paranaensis* (eggs + Second-stage juveniles, J2) was evaluated in the roots of the new cultivars in the F_6 generation, as well as in the roots of IPR 100, resistant cultivar, and of Catuaí Amarelo IAC 62, susceptible cultivar, used as checks. Four subsamples of roots were collected from equidistant points 20 cm from the central axis of the plant at a depth of 30 cm, perpendicular to the direction of the crop line. The samples were collected in 2019 and 2020. Nematodes were extracted according to Hussey and Barker, adapted by Bonetti and Ferraz (1981) and counted using a Peter's slide under a biological microscope. Population density was expressed as the number of eggs + J2 per gram of roots (NEM g^{-1}).

Table 1. Yield (bags ha^{-1}) and number of eggs+ J2 per gram of roots (NEM g^{-1}) in root samples of MGS Guaiçara and MGS Vereda in area infestaded by *Meloidogyne paranaensis*

Cultivars	YIELD*	NEM g^{-1}**	
		2019	2020
MGS Guaiçara	16.5c	35.7c	74.0b
MGS Vereda	29.9a	184.6b	94.0b
IPR 100	23.9b	37.3c	40.9b
Catuaí Amarelo IAC 62	7.7d	2423.6a	2358.0a
CV (%)	32.74	62.8	50.9

Averages followed by the same lowercase letter in the column did not differ significantly according to the Scott-Knott test at 5% significance. * Mean of first three harvests of F_6 generation at 3.0 m x 0.6 m spacing ** Data of NEM g^{-1} was transformed in √(x +0.5).

Both *M. paranaensis*-resistant cultivars showed potential for reducing nematode populations in the soil (Table 1); they exhibited lower average numbers of eggs and second-stage juveniles per gram of roots (Nem.g^{-1}) compared to the check cultivar (Catuaí Amarelo IAC 62). There was a reduction of more than 90% in the *M. paranaensis* population in the two resistant cultivars compared to cultivar Catuai, characterizing these new cultivars as resistant (Hussey and Janssen 2002).

PLANTING RECOMMENDATIONS

The MGS Guaiçara and MGS Vereda cultivars were evaluated in areas naturally infested by *M. paranaensis* across the west-central region of Minas Gerais (Piumhi). The experiments were set up on a private farm in the municipality of Piumhi, in western Minas Gerais (lat 20° 27′ 54″ S, long 45° 57′ 28″ W, alt 793 m asl). The experiment was conducted in an area of flat topography with a slight slope. The climate in Piumhi is classified as a subtropical mesothermal temperate climate, with a rainy and hot summer and dry winter, Cwa according to the Köppen climate classification.

Generation F_3, F_4, and F_5 progenies were evaluated in the Cerrado Mineiro region (Patrocínio, Carmo do Paranaíba) and in fields free of nematodes located in the south of Minas (Três Pontas). Both cultivars are recommended for growing in areas infested by *M. paranaensis*.

While MGS Vereda is an early maturation cultivar, MGS Guaiçara has a medium maturation cycle (similar to Catuaí), thereby enabling management of maturation cycles for staggered harvesting. Recommended plant spacing within the row is 0.7 m, but can be reduced to 0.6 m. In that case, with a larger number of plants per area, periodic thinning and pruning practices are assumed to be essential. The inter-row spacing may vary according to the management and production system adopted.

Table 2. Morpho-agronomic traits of MGS Guaiçara e MGS Vereda Arabica coffee cultivars

Traits	
Plant height (size)	High
Canopy shape	Conical
Canopy diameter	Medium
Internode	Length
Secondary branching:	High
Color of leaves (shoots)	Green (when young and adults)
Leaf size	Medium
Color of ripe fruit	Red
Fruit shape	Oblong
Seed size	Medium to large
Seed shape	Wide
Leaf blade edges	Slightly undulate
Rust resistance	No
M. paranaensis resistance	High
Vegetative vigor	High

SEED MAINTENANCE AND DISTRIBUTION

The cultivars MGS Guaiçara and MGS Vereda are registered in the national cultivar registration agency (Registro Nacional de Cultivares - RNC) of the Brazilian Ministry of Agriculture (Ministério da Agricultura, Pecuária e Abastecimento - MAPA) under numbers 46549 and 46710, respectively. EPAMIG is responsible for maintaining the genetic material (seeds).

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