

MGS Turmalina: A short rust-resistant Arabica coffee cultivar with drought tolerance and superior beverage quality

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Abstract: The MGS Turmalina coffee cultivar is short in size, matures early, and is rust resistant. It has demonstrated a higher yield than the Catuaí Vermelho IAC 99 cultivar in different regions, standing out in environments with greater water deficit. The market value of MGS Turmalina beans is higher due to its superior cup quality.

Keywords: *Coffea arabica* L., *Hemileia vastatrix*, cup quality, productivity, water deficit

INTRODUCTION

Arabica coffee (*Coffea arabica* L.) production in Brazil plays a key role in the country's economy and export sector, and demands constant innovation to address agronomic and market challenges. Developing cultivars with high yield, resistance to major diseases, and distinct sensory quality is fundamental to ensuring the environmental, economic, and social sustainability of coffee production. Higher-yielding and disease-resistant cultivars reduce the need for chemical inputs, lower production costs, and promote more efficient land use. At the same time, cultivars with excellent cup quality open opportunities in the specialty coffee market, adding value for producers and supporting rural development (Van der Vossen et al. 2015, Almeida et al. 2024).

In this context, the Minas Gerais State Research System (EPAMIG/UFLA/UFV, EMBRAPA Café) has been actively engaged in genetically improving coffee plants, generating cultivars adapted to the diverse soil and climate conditions in Brazil. Comparative yield studies conducted in different regions have demonstrated that MGS Turmalina exhibits superior agronomic performance compared to traditional cultivars such as Catuaí Vermelho IAC 99. In addition to its high productivity, MGS Turmalina stands out for its moderately early fruit ripening earlier than traditional cultivars such as Catuaí, its compact plant size which facilitates harvesting, and its excellent cup quality. It consistently scores high in sensory analyses and performs well under water-deficit conditions. Its performance

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in specialty coffee competitions and appreciation in the market highlight its potential for Brazilian coffee production.

This article aims to present the main characteristics of the MGS Turmalina cultivar. A detailed understanding of the selection process and attributes of this cultivar can support decision-making by producers and researchers interested in innovations in coffee cultivation.

HISTORY

The MGS Turmalina cultivar was developed through artificial hybridization in the late 1970s, involving the Catuaí Amarelo IAC 30 cultivar (UFV 2143-235 EL7) and the Timor Hybrid UFV 445-46, with the latter serving as a source of rust-resistant genes (Silva et al. 2023). The resulting segregating population was advanced using the genealogical method. Then in 1980, ten F_1 hybrid plants were obtained through artificial hybridization carried out in experimental areas of the Department of Phytopathology at the Federal University of Viçosa (UFV).

Timor Hybrid UFV 445-46, used as the male parent, originated from accession C1FC 2570, which had been collected in Timor and was sent to the Coffee Rust Research Center in Oeiras, Portugal. Seeds of this accession were sent to Angola, where they were cultivated at the Uíge Regional Station (ERU). A rust-resistant plant was selected from this crop and registered as ERU 209-15. Seeds from this selected plant were subsequently introduced to the Federal University of Viçosa (UFV), giving rise to UFV 445-46.

The ten F_1 plants resulting from this cross were named as H419-1 to H419-10 and cultivated in the Hybrid Selection Field No. 8 (CSH 8) at UFV in Viçosa, MG. The F_1 plant identified as H419-3 was selected in pit 77 of CSH 8, and its progenies in the F_2 , F_3 , and F_4 generations were evaluated in replicated productivity trials at the Experimental Field of the Minas Gerais Agricultural Research Corporation (EPAMIG) in São Sebastião do Paraíso (CESP). Plants from the F_4 generation were selected to generate progenies which were planted in competition experiments that assessed grain yield, vegetative vigor, and rust resistance.

Next, a progeny from the F_5 generation was evaluated in an experiment at Fazenda Makena, located in the municipality of Patrocínio, in the Alto Paranaíba region, MG, in which a rust-resistant plant was selected, named as H419-3-3-7-16-11. The offspring of this plant gave rise to the F_6 generation, evaluated for productivity in a trial including 25 progenies at Fazenda Turmalina, in the municipality of Turmalina, MG. Several plants were selected to collect a mixture of seeds from the F_7 generation, which was then used to set up a comparative experiment with 25 progenies at Fazenda Amizade, in the municipality of Campos Altos, MG.

Another plant selection from the F_7 generation was performed to form a seed mixture, giving rise to the F_8 generation (H419-3-3-7-16-11-1-1-1), which was evaluated in a multiplication and selection field at Fazenda Amizade. Basic seeds were collected in this field to establish the MGS Turmalina cultivar, derived from the F_9 generation (H419-3-3-7-16-11-1-1-1-1).

MORPHOLOGICAL CHARACTERISTICS

The main morphological characteristics of the MGS Turmalina cultivar, obtained from eight-year-old coffee plants, are shown in Table 1.

PRODUCTIVITY

The productivity of the MGS Turmalina cultivar was evaluated under different soil and climate conditions, demonstrating superior performance compared to the Catuaí Vermelho IAC 99 cultivar. The average productivity of the MGS Turmalina cultivar in an experiment conducted at Fazenda Turmalina over the first nine harvests was 29.0 bags ha^{-1} , while the Catuaí Vermelho IAC 99 cultivar had an average productivity of 23.9 bags ha^{-1} under rust control conditions. The experiment used a 4.0 x 1.0 m spacing and was conducted under rainfed conditions in a region historically subject to water deficits (Table 2).

Then in another experiment conducted at Sítio São Pedro in the municipality of Araponga, MG, and evaluated over three harvests under rainfed conditions, the MGS Turmalina cultivar showed an average productivity of 40.5 bags of

Table 1. Morphological characteristics of the MGS Turmalina cultivar

Characteristics	Description
Size	Small
Average height	2.82 m
Stem diameter	6.83 cm
Plant architecture	Conical shape
Crown diameter – lower third	2.00 m
Tree size – middle third	1.90 m
Plagiotropic branches	Short internodes, with abundant secondary branches
Color of ripe fruits	Yellow
Seed size	Medium
Color of young leaves	Predominantly bronze
Maturation	Early compared with the cultivars of the Catuaí group

Table 2. Productivity (bags ha⁻¹) of the MGS Turmalina cultivar and cultivars used as a control in different locations in the State of Minas Gerais, Brazil

Location ¹	Productivity			
	MGS Turmalina	Catuaí V. IAC 99	Catuaí 24/137	Catuaí V. IAC 144
Turmalina	29.00 a	23.90 b	-	-
Araponga	40.50 a	37.80 b	-	-
Paula. Cândido	47.70 a	-	43.60 b	39.10 b

V. red A. yellow. Means followed by different letters in the rows indicate significant differences among treatments according to the Scott-Knott test.

processed coffee per hectare, surpassing the control ‘Catuaí Vermelho IAC 99’, with an average productivity of 37.8 bags ha⁻¹. This experiment was implemented at a spacing of 2.50 x 0.60 m and included other commercial rust-resistant cultivars, demonstrating the productive potential of MGS Turmalina (Table 2).

Next, an experiment was conducted at Sítio Dona Maria, in the Airões District, Paula Cândido municipality (MG), at an altitude of 695 m (lat 20° 48’ 89’’ S, long 42° 58’ 89’’ W), using a spacing of 2.50 x 0.50 m. As a result, MGS Turmalina stood out as the most productive among the 20 treatments evaluated. The experiment was conducted under rainfed conditions and included traditional cultivars such as Catuaí Vermelho IAC 144, elite cultivars, and rust-resistant progenies. The average productivity of MGS Turmalina considering four harvests between 2014 and 2017 was 47.7 bags ha⁻¹, surpassing the Catuacaiam 24137 cultivar, with 43.6 bags ha⁻¹ and Catuaí Vermelho IAC 144 (39.1 bags ha⁻¹) (Table 2).

BEVERAGE SENSORY QUALITY

The MGS Turmalina cultivar presents excellent cup quality and is recognized in specialty coffee competitions. It ranked 3rd in the “Natural Coffee” category in the 12th edition of the Cerrado Mineiro Coffee Awards held by the Federation of Cerrado Coffee Growers in Uberlândia, MG, with a score of 88.15 points. It was distinguished by notes of jasmine, vanilla, and red berries such as blackberry, plum, and raspberry.

Another significant milestone was the Solidarity Coffee Auction, which took place during the awards ceremony. A single bag of MGS Turmalina coffee was sold in 2024 for R\$ 115,000, equivalent to approximately US\$19,300 at the prevailing exchange rate, thereby establishing a new national record for the highest price ever paid for a bag of coffee in Brazil. The lot was purchased by a consortium consisting of Carpec, Louis Dreyfus, and Sebrae Minas, highlighting the cultivar’s recognition and value in the specialty coffee market.

It is important to highlight that the MGS Turmalina cultivar maintains its capacity for specialty coffee production even in lower-altitude regions typically considered marginal for *C. arabica* cultivation. This reflects its remarkable adaptability to diverse soil and climate conditions, ensuring high cup quality despite environmental challenges. In a field trial conducted at 640 m a.s.l. in the transitional altitude zone of Alegre, Espírito Santo, MGS Turmalina outperformed other cultivars

across different water management systems, including irrigated, rainfed, and fertigated. It demonstrated agronomic stability and consistently achieved sensory scores above 84 points on the SCA scale, even under rainfed conditions. These findings confirm its potential for sustainable cultivation in regions subject to climate variability and water constraints. Notably, MGS Turmalina excelled under irrigation, while Sacramento MG1 showed the best performance under fertigation, and Catuaí Vermelho IAC 44 under rainfed conditions. The results underscore the importance of matching genotype with appropriate water management to achieve high productivity and quality, offering a strategic pathway to maintain coffee production in areas facing the impacts of climate change.

DROUGHT TOLERANCE

As previously mentioned, the MGS Turmalina cultivar was developed with a focus on resistance to biotic stress factors and tolerance to drought conditions. In a study to identify drought-tolerant *Coffea arabica* progenies (Silva et al. 2022), MGS Turmalina (identified as genotype H419-3-3-7-16-11) was outstanding in both greenhouse and field experiments. The study evaluated 10 advanced progenies derived from crosses between Catuaí and Timor Hybrid lines, alongside three reference cultivars: Catuaí Vermelho IAC 99, Catuaí Vermelho IAC 144, and Siriema. These controls were chosen based on their commercial relevance and, in the case of Siriema, well-documented adaptability to water deficit (Dias et al. 2007).

Morphological, anatomical, and physiological traits were assessed under well-watered and drought-stress conditions. The MGS Turmalina genotype demonstrated superior root development, leaf area, and shoot biomass under drought. It also showed anatomical traits such as greater xylem vessel number and phloem thickness, with these parameters being associated with improved water transport efficiency. It notably achieved a heritability of 92% for phloem thickness and 89% for xylem vessel number, with gains in total biomass and root mass of over 9% and 8%, respectively, compared to the population mean.

Field trials conducted in a water-deficit region (Turmalina city, located in the Jequitinhonha Valley, MG) over five consecutive harvests validated the greenhouse results. MGS Turmalina maintained high productivity under natural drought conditions and was one of only two genotypes, alongside H516-2-1-1-7-2, which consistently performed well across both environments. These findings confirm the effectiveness of combining anatomical selection under controlled conditions with productivity performance in the field to identify elite drought-tolerant cultivars.

ENVIRONMENTAL ADAPTATION

The MGS Turmalina cultivar has a growth cycle of 6 to 8 months for seedling establishment and approximately 30 months from planting to the first harvest. Planting is recommended at the beginning of the rainy season to ensure adequate water availability for initial plant establishment. In terms of agronomic management, the recommended spacing varies depending on the cultivation system used. The recommendation under high-density planting systems is 2.5 to 3.0 m between rows and 0.50 to 0.80 m between plants, while a spacing of 3.0 to 4.0 m between rows is recommended in the conventional system.

The MGS Turmalina cultivar has been tested under various climatic and soil conditions, including the altitude of Campos Altos and Turmalina, municipalities in the state of Minas Gerais. The average annual temperature in Campos Altos is 20.7 °C, with an average annual minimum of 14.8 °C and an average maximum of 27.9 °C. The annual rainfall index is 1,435 mm, mainly concentrated in the rainy season, with a cold and dry period from May to September. The predominant topography is flat, favoring mechanized management. The average annual temperature in the municipality of Turmalina is 21.3 °C, with average minimums of 16.3 °C and average maximums of 29.8 °C. Annual precipitation is slightly higher, reaching 1,450 mm. Adaptations such as terracing or contour planting may be required in regions with undulating topography to ensure adequate drainage and facilitate mechanized operations.

SEED MAINTENANCE AND DISTRIBUTION

The MGS Turmalina cultivar is registered in the National Register of Cultivars (RNC) under the Brazilian Ministry of Agriculture, Livestock, and Food Supply (MAPA) with registration number 49086. EPAMIG is responsible for maintaining the foundation seed stock.

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DATA AVAILABILITY

The datasets generated and/or analyzed during the current research are available from the corresponding author upon reasonable request.

REFERENCES

- Almeida DPD, Carneiro DG, Caixeta ET, Alves DR and Zambolim L (2024) New and efficient AS-PCR molecular marker for selection of coffee resistant to coffee leaf rust. **Crop Breeding and Applied Biotechnology** 24: e498424410.
- Dias PC, Araujo WL, Moraes GABK, Barros RS and DaMatta FM (2007) Morphological and physiological responses of two coffee progenies to soil water availability. **Journal of Plant Physiology** 164: 1639-1647.
- Silva VA, Abrahão JCR, Reis AM, Santos MO, Pereira AA, Botelho CE, Carvalho GR, Castro EM, Barbosa JPRAD, Botega GP and Oliveira ACB (2022) Strategy for selection of drought-tolerant arabica coffee genotypes in Brazil. **Agronomy** 12: 2167.
- Silva AG, Ariyoshi C, Shigueoka LH, Pereira LFP and Sera GH (2023) Assisted selection using molecular markers linked to rust resistance SH₃ gene in *Coffea arabica*. **Crop Breeding and Applied Biotechnology** 23: e445323413.
- Van der Vossen H, Bertrand B and Charrier A (2015) Next generation variety development for sustainable production of arabica coffee (*Coffea arabica* L.): a review. **Euphytica** 204: 243-256.



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