Optical chlorophyll sensor in the identification of coffee cultivars adapted to the Pitangui-MG region

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Abstract.

The agronomic performance of coffee plants is directly related to the interaction between genotype and environment, making it essential to identify cultivars best adapted to specific growing conditions. In recent years, the incorporation of tools in agriculture has significantly improved the plant evaluation process. Among these technologies, portable sensors, such as the chlorophyll meter, allow for rapid, non-destructive, and highly sensitive measurements of physiological parameters related to the nutritional status and photosynthetic efficiency of plants. Furthermore, morphological characteristics such as height, stem diameter, and number of plagiotropic branches remain essential parameters for understanding the growth, vigor, and reproductive potential of coffee plants. An integrated analysis of these attributes allows for the identification of cultivars with better regional adaptation capacity, contributing to the establishment of more productive and sustainable practices. Therefore, this study aimed to evaluate the morphophysiological characteristics of different Arabica coffee cultivars, using growth indicators and physiological functionality as parameters to infer their regional adaptation. The experiment was implemented in January 2025 at the farm of the Pitangui Agricultural Technological Institute (ITAP), located in the municipality of Pitangui, Minas Gerais. The experimental design adopted was a randomized complete block design (RCBD) with six replications. Five Arabica coffee cultivars were evaluated, constituting the treatments: T1 – Arara; T2 – Catucaí Amarelo 137; T3 – Catiguá Amarelo; T4 – MGS Paraíso; and T5 – Gesha. Planting was carried out at a spacing of 0.7 × 3.5 m, with each experimental plot consisting of eight plants, of which six were useful for the evaluations. The cultivation was continuous in a rainfed system. The analyses tested included total chlorophyll content, plant height, stem diameter, and number of plagiotropic branches, characterizing the physiological state and initial development of the coffee plants. Regarding morphological parameters, the highlighted stem diameter is a consistent indicator of plant vigor.

The Catucaí Amarelo 137 and MGS Paraíso cultivars stood out from the other genetic materials, presenting high chlorophyll content (73.00 and 73.33, respectively) associated with larger stem diameter values (3.5 mm and 3.8 mm, respectively). It is concluded that the Catucaí Amarelo 137 and MGS Paraíso cultivars stood out for presenting superior responses, providing greater physiological efficiency, and better initial plant establishment. These results reinforce the potential of using optical sensors as a strategic tool in cultivar selection and recommendation programs, contributing to decision-making in more efficient production systems adapted to local conditions.

Keywords.
Coffea arabica cultivars, chlorophyll meter, coffee plant morphophysiology

Introduction

The agronomic performance of coffee plants is directly related to the interaction between genotype and environment, making it essential to identify cultivars best adapted to specific growing conditions (Rodrigues et al., 2023). In recent years, the incorporation of tools in agriculture has significantly improved the plant evaluation process. Among these technologies, portable sensors such as the chlorophyll meter allow for rapid, non-destructive, and highly sensitive measurements of physiological parameters related to the nutritional status and photosynthetic efficiency of plants. Furthermore, morphological characteristics such as height, stem diameter, and number of plagiotropic branches remain essential parameters for understanding the growth, vigor, and reproductive potential of coffee plants. An integrated analysis of these attributes allows for the identification of cultivars with better regional adaptation capacity, contributing to the establishment of more productive and sustainable practices. Therefore, this study aimed to evaluate the morphophysiological characteristics of different Arabica coffee cultivars, using growth indicators and physiological functionality as parameters to infer their regional adaptation.

Materials and Methods

The experiment was installed in February 2025 at the EPAMIG ITAP Agricultural Technological Institute of Pitangui (ITAP) farm, in Pitangui-MG, within the geographic regions of 19º70’58’’ South latitude and 44º88’68’’ West longitude. The climate in Pitangui (MG) is affected by average annual maximum temperatures around 27–29 °C and average minimum temperatures in the range of 14–20 °C, with wetter summers and drier winters, typical of a tropical highland climate (Climatempo, 2025). The experiment was conducted in a randomized block design with 6 replications. Five Arabica coffee cultivars were evaluated, which constituted the treatments: T1: Arara, T2: Catucaí Amarelo 137, T3: Catiguá Amarelo, T4: MGS Paraíso, and T5: Gesha. The spacing used was 0.7 x 3.5 m, with 8 plants per experimental plot, conducted in a rainfed system. The following measurements were performed on 6 representative plants from each plot: Plant height (cm): measured from ground level to the apex; Stem diameter (mm): measured at ground level using a digital caliper; Number of plagiotropic branches: total count of productive branches present on the plant; and Total chlorophyll index: determined with a portable chlorophyll meter - ClorofiLOG® CFL 2060, Falker Automação Agrícola Ltda., Porto Alegre, RS, Brazil (Fig. 1). The parameters used considered the growth increment from May to October, with the exception of chlorophyll. Morphophysiological values were subjected to analysis of variance and comparison of means using the statistical software RStudio 4.5.1. Mean values were compared using the Scott-Knott test, with a significance level of 5%.

Fig 1. Experimental Area (A) and Chlorophyll Index Analysis (B) Photo: Prepared by the authors (2025)

Results and Discussion

According to the results, chlorophyll content showed a statistically significant and efficient difference between the evaluated cultivars, demonstrating that the use of the chlorophyll meter optical sensor was effective in discriminating the performance of the trained genetic materials. Since chlorophyll is directly associated with the photosynthetic capacity of plants, its evaluation contributes to the identification of cultivars with greater vigor and physiological efficiency (Taiz et al., 2023). The sensitivity of the chlorophyll meter in detecting physiological variations between cultivars contributes to the identification of differences in productive potential, since chlorophyll content is associated with efficiency in light use and carbon assimilation (Table 1).

Tab 1. Mean values of Arabica coffee cultivars: 1 (Arara), 2 (Catucaí Amarelo 137), 3 (Catiguá Amarelo), 4 (MGS Paraíso 2) e 5 (Gesha) evaluated during the first year of cultivation.

Cultivars	Total Chlorophyll	Stem diameter (mm)	Height (cm)	Number of plagiotropic branches
1	62.83 B	2.0 B	9.50 A	6.00 A
2	73.00 A	3.5 A	8.25 A	6.00 A
3	75.50 A	2.0 B	6.00 A	5.00 A
4	73.33 A	3.8 A	8.77 A	7.00 A
5	69.33 A	2.0 B	12.18 A	5.00 A

Media followed by the same letter in the column are not statistically significant to each other, according to the Scott-Knott test with a 5% probability.

Regarding morphological parameters, stem diameter, highlighted as a consistent indicator of plant vigor, proved to be an effective tool. The Catucaí Amarelo 137 and MGS Paraíso cultivars stood out from the other genetic materials, presenting high chlorophyll content (73.00 and 73.33, respectively) associated with the highest stem diameter values (3.5 mm and 3.8 mm, respectively). The Catucaí Amarelo 137 and MGS Paraíso cultivars stood out for presenting superior responses, providing greater physiological efficiency and better initial plant establishment. These results reinforce the potential of using optical sensors as a strategic tool in selection programs and recommendation of cultivars, contributing to decision-making in more

efficient production systems adapted to local conditions.

The differences observed between cultivars regarding chlorophyll content and stem diameter reflect distinct physiological strategies for assimilate allocation. Higher chlorophyll content does not necessarily imply greater structural growth, since these variables vary independently of genotype and environmental conditions. However, obtaining coffee cultivars with a high chlorophyll index associated with an adequate stem diameter is interesting. In this context, cultivars 2 (Catucaí 137) and 4 (MGS Paraíso 2) stand out, as they combine these characteristics, contributing to the formation of more vigorous plants with greater productive potential.

The lack of significance observed for plant height and number of plagiotropic branches indicates similar behavior among the cultivars evaluated under the edaphoclimatic conditions of the experiment. This result may be related to the relatively short evaluation period, which may not have allowed for the complete expression of vegetative growth differences between the genetic materials. Thus, the results reinforce the importance of physiological evaluations in the characterization of coffee cultivars, since these tools are more sensitive to the differentiation between genetic materials and allow for the detection of early responses to the environment and management, even when vegetative growth characteristics do not show significant differences.

Conclusion

It is concluded that the Catucaí Amarelo 137 and MGS Paraíso cultivars stood out for presenting superior responses, providing greater physiological efficiency and better initial plant establishment. These results reinforce the potential use of optical sensors as a strategic tool in cultivar selection and recommendation programs, contributing to decision-making in more efficient production systems adapted to local conditions.

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References

Climatempo. Climatologia em Pitangui – MG: médias de temperatura e chuva (2025). Disponível em: https://www.climatempo.com.br/climatologia/177/pitangui-mg. Acesso 16 dez. 2025.

Rodrigues, W. P. et al. (2023). Adaptability and stability of Coffea arabica cultivars in different environments using mixed models. *Coffee Science*, Lavras, v. 18, e181999.

Taiz, l.; Zeiger, e.; Møller, I. M.; Murphy, A**.** (2023). *Fisiologia e desenvolvimento vegetal*. 7. ed. Porto Alegre: Artmed.