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Morphological characterization of new banana clones-elites

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Abstract: The characterization of clones is a very important step in genetic certification programs, as it describes and recognizes the plant material at every stage of production, allowing the monitoring of genetic quality, improvement and conservation of the germplasm. The aim of this work was to morphologically characterize two elite banana clones. The experimental design applied was in randomized blocks, with four replications, with six plants per parcel. The treatments consisted of two elite banana clones, Prata Gorutuba R1 and Prata Gorutuba R2 and four commercial cultivars: Prata Gorutuba, Prata Ana, Grande Naine and BRS Princesa. The morphological characterization was carried out in the second production cycle (daughter plant), using 23 qualitative descriptors, visually evaluated, classified according to the instructions for carrying out the distinguishability, homogeneity and stability (DHS) tests of banana cultivars. The elite clones Prata Gorutuba R1 and R2 differed from the cultivars Grande Naine and BRS Princesa regarding the descriptors tapering of the pseudostem, predominant color of the pseudostem, intensity of anthocyanin coloration and color of the underside of the basal sheath. The descriptors made it possible to group elite clones into the Prata group, a group that predominates in crops in Brazil, with characteristics already widely accepted by the market.

Terms for indexing: *Musa* spp.; 'Prata Gorutuba'; 'Prata-Ana'; Cultivars registration.

Caracterização morfológica de novos clones-elites de bananeira

Resumo: A caracterização dos clones é uma etapa de suma importância em programas de certificação genética, pois descreve e reconhece o material vegetal em toda etapa de produção, permitindo o monitoramento da qualidade genética, o melhoramento e a conservação do germoplasma. Objetivou-se com este trabalho caracterizar, morfologicamente, dois clones-elites de bananeira. O delineamento utilizado foi em blocos ao acaso, com quatro repetições, sendo seis plantas úteis. Os tratamentos foram compostos por dois clones-elites de bananeira Prata Gorutuba R1 e Prata Gorutuba R2 e quatro cultivares comerciais: Prata Gorutuba, Prata-Anã,

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Grande Naine e BRS Princesa. A caracterização morfológica foi realizada no segundo ciclo de produção (planta-filha), utilizando 23 descritores qualitativos, avaliados visualmente, classificados de acordo com as instruções para execução dos ensaios de distinguibilidade, homogeneidade e estabilidade (DHE) de cultivares de bananeira. Os clones-elites Prata Gorutuba R1 e R2 diferiram das cultivares Grande Naine e BRS Princesa referente aos descritores afunilamento do pseudocaule, cor predominante do pseudocaule, intensidade da coloração antocianínica e cor da face inferior da bainha basal. Os descritores possibilitaram agrupar os clones-elites no grupo Prata, grupo este predominante em cultivos no Brasil, com características já amplamente aceitas pelo mercado.

Termos para indexação: *Musa* spp.; 'Prata Gorutuba'; 'Prata-Anã'; Registration of cultivars.

Introduction

The most common banana cultivars in the Brazilian market are the 'Prata', 'Nanica', 'Maça', 'Terra', 'Ouro' and 'Marmelo' bananas. This narrow genetic base, associated with the susceptibility of these materials to some phytopathogens, makes Brazilian banana farming very vulnerable (SILVA et al., 2008). In the wild species of banana, there is a very important genetic variability for improvement, due to its combination of characteristics of resistance to phytopathogens and environmental changes (DIAS; BARRETO, 2011; AMORIM et al., 2016). Of the sources of generation of genetic variability in banana, there are natural mutations and somaclonal variations that come from in vitro cultivation (SONIYA et al., 2001). The somaclonal variants and natural mutants are extremely important as genetic resources, and can be used directly or indirectly in genetic improvement programs, for the development of new cultivars or in the selection of superior banana clones (HWANG; KO, 2004).

The banana trees are attacked by several phytopathogens, and the most important fungi are the causative agents of yellow-Sigatoka (*Mycosphaerella musicola,* Leach), black-Sigatoka (*M. fijiensis*, Morelet) and fusariosis (*Fusarium oxysporum* f. sp. *cubense*). The fusariosis has been an important limiting factor to the expansion of the crop in several regions of Brazil and the best control strategy for this disease has been the use of resistant cultivars. Since 2010, the research group on Fruit Growing and Genetic Improvement at the State University of Montes Claros has carried out several studies related to the selection and evaluation of superior banana clones. Rodrigues et al. (2010) and Silva (2010) made significant contributions to their work and allowed the selection of two banana somaclonal variants, Prata Gorutuba R1 and Prata Gorutuba R2, with relevant commercial characteristics, as well as high levels of tolerance to fusariosis.

After completing this first phase of the project, the team proceeded with the process of characterizing the clones, an extremely important step in genetic certification programs, as it describes and recognizes the plant material at every stage of production, allowing the monitoring of genetic quality, improvement and germplasm conservation (ZUBRZYCKI, 1997; BIANCHI et al., 2004). In Brazil, the regulatory body is the Ministry of Agriculture, Livestock and Supply (MALS), which provides mechanisms for registering and organizing detailed information on the characteristics of cultivars qualified for production and commercialization throughout the national territory, establishing the National Registry of Cultivars (NRC) (CARVALHO et al., 2009). This record is of paramount importance, as it protects the farmer from buying seeds and seedlings not evaluated in the Brazilian edaphoclimatic conditions. It is a simple and inexpensive process compared to cultivar protection, as well as being easily adopted by the public and private sectors (CARVALHO et al., 2009).

Thus, the aim of this work was to morphologically characterize two elite banana clones, Prata Gorutuba R1 and Prata Gorutuba R2.

Materials and Methods

The experiment was implemented in August 2018, on a commercial property, located in the municipality of Nova Porteirinha, MG, with the geographic coordinates 15°47'22''S and 43°16'48''O, on 556 m of altitude. The climate in the region, according to the Köppen classification, is type Aw, tropical, with an average rainfall of approximately 800 mm, an average minimum temperature of 19° and maxims of 30°.

The design used was randomized blocks (DBC), with four replications and 20 plants per plot, six of which were useful plants. The six treatments consisted of elite banana clones Prata Gorutuba R1 and Prata Gorutuba R2, genotypes of the AAB genomic group, derived from somaclonal variation of the 'Prata-Ana' clone Gorutuba and selected in the experimental area of the Banana Genetic Improvement Program of Unimontes, and by four cultivars: Prata Gorutuba (AAB), Prata-Ana (AAB), Grande Naine (AAA) and BRS Princesa (AAAB).

The seedlings of the cultivars Prata-Ana, Grande Naine and the elite clones Prata Gorutuba R1 and Prata Gorutuba R2 were collected at the Experimental Farm of the State University of Montes Claros and the seedlings of the cultivar Prata Gorutuba and BRS Princesa came from nearby rural properties in the North region of Minas Gerais. The seedlings used in this experiment were of the horn type. The planting spacing used was 3,5 m x 1,7 m. The cultural treatments, irrigation and fertilization of the banana plantation were carried out in accordance with Donato et al. (2021).

The morphological characterization was carried out in the second production cycle (daughter plant), using 23 qualitative descriptors, visually evaluated, classified according to the instructions for carrying out the distinguishability, homogeneity and stability (DHE) tests of banana cultivars (*Musa* spp.) available on the MALS website (2018). After the proposed classification for each descriptor, descriptive statistics of the MODA type were used for the final classification of the descriptors.

Results and discussion

The cultivars Grande Naine, Princesa and Prata-Ana were characterized as absent or weak in the degree of funneling of the pseudostem, unlike the elite clones Prata Gorutuba R1, R2 and the cultivar Prata Gorutuba, which presented a medium degree of funneling (Table 1). The predominant color of the banana pseudostem for the evaluated genotypes was yellow-green, except for the cultivars Grande Naine, with purple color and BRS Princesa with light green color (Table 1, figure 1). Silva (2016) emphasizes that the tapering is a very variable characteristic and difficult to distinguish. In banana plants of the AAA genomic group and some AAAB tetraploid hybrids, the pseudostem is characteristically greenish-brown in color with a bright pink color at the junction with the petiole. In bananas of the AAB genomic group, the coloration is green and in ABB it is more intense green (SALINAS et al., 2021).

Table 1. Classification of pseudostem and plant morphological descriptors in different banana genotypes. Nova Porteirinha, MG, 2021.

Genotypes	PT	PCP	IACP	CLPBS	PCC	PGH	LPC
Prata Gorutuba R1	Average	Greenish yellow	Absent or very weak	Green	Average	Open	Curved out
Prata Gorutuba R2							
Prata Gorutuba							
Prata Ana	Absent or weak						
Grande Naine		Purple	Strong	Purple			
BRS Princesa		Light green	Average	Green	Laxa		

PT: Pseudostem tapering; PCP: Predominant color of the pseudostem; IACP: Intensity of anthocyanin staining; CLPBS: Color of the lower phase of the basal sheath; PCC: Plant crown compactness; PGH: Plant growth habit; LPC: Leaf petiole canal.

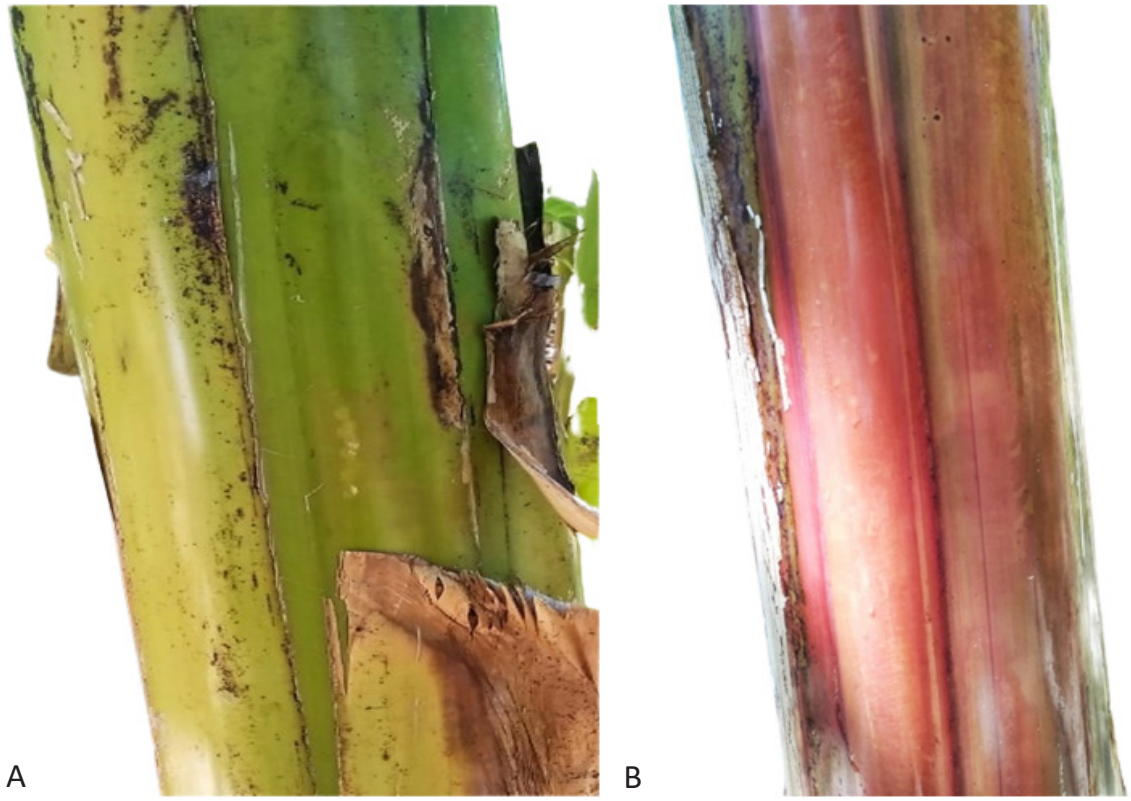

Figure 1. Classification of pseudostem and plant morphological descriptors: Predominant pseudostem color (PPC) (A: Greenish yellow, B: Purple) and Intensity of anthocyanin staining (IACP) (A: Absent or very weak B: Strong) of the pseudostem genotypes banana tree. Nova Porteirinha, MG, 2021. A) Clones-elites Prata Gorutuba R1; B) 'Grande Naine'.

It was observed that the clones-elite Prata Gorutuba R1 and R2 and the Prata type cultivars obtained the anthocyanin coloring intensity in the peritoneum classified as absent or very weak. On the other hand, the 'Grande Naine' showed a strong anthocyanin color and the 'BRS Princesa' medium color (Table 1). The anthocyanins are responsible for the various shades of color found in flowers, fruits and leaves (MAZZA; MINIATI, 1993). Different results were found by Rodrigues (2010), who showed that 'Prata Ana' had the presence of anthocyanin and 57% of the clones of 'Prata Ana' Gorutuba had anthocyanin basically throughout the peritoneum. Silva et al. (1999) consider it common for anthocyanin deposition to occur in the AAA genomic group, these dark spots being typical of AAA accessions. *M. acuminata*. In this way, it can be assumed that the genotypes that have the presence of the A genome will consequently have an increase in staining intensity.

The cultivar Grande Naine differed in the characteristic color of the underside of the basal sheath with the purple color in relation to the other genotypes, which presented a green color. The cultivar BRS Princesa also differed from the other genotypes, showing the compactness of the lax crown, that is, an open crown, while the others showed medium crown compactness (Table 1, figure 2). The descriptors for growth habit and petiole canal obtained grade 1 for all evaluated cultivars, being considered as open growth habit and the petiole canal erect (Figure 3).

In general, the descriptors in table 1 were similar within the Prata banana trees, with a slight difference only in the tapering of the pseudostem for 'Prata-Ana', demonstrating the uniformity of the elite clones Prata Gorutuba R1 and R2 in relation to the Prata Gorutuba clone, thus showing that elite clones have morphological characteristics already accepted by consumers.

Figure 2. Classification of pseudostem and plant morphological descriptors: Difference between plant crown compactness (PCC) (A: Average, B: Laxa) of banana genotypes. Nova Porteirinha, MG, 2021. A) Clones-elites Prata Gorutuba R1, B) 'BRS Princesa'.

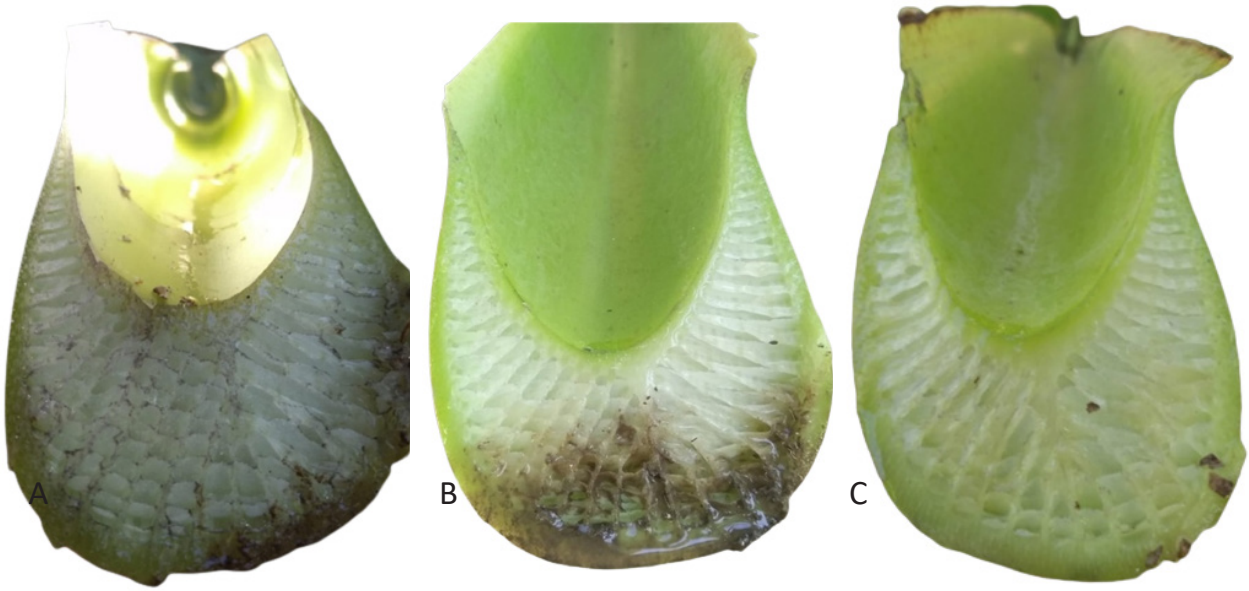

Figure 3. Classification of pseudostem and plant morphological descriptors: similarities of the petiole canal (PC) of banana genotypes (A: Curved out, B: Curved out, C: Curved out). Nova Porteirinha, MG, 2021. A) Clone-elite Prata Gorutuba R1, B) Clone-elite Prata Gorutuba R2, C) Prata Gorutuba.

In all evaluated genotypes, the color of the lower vein was characterized as green, the waxiness in the lower phase was absent or very weak and the brightness of the upper surface was considered absent. For the leaf base shape descriptor, the cultivar BRS Princesa has both sides acute, while the elite clones Prata Gorutuba R1 and R2, the cultivars Prata Gorutuba and Prata-Ana have both sides of their leaf bases rounded (Table 2, figure 4).

Table 2. Classification of leaf morphological descriptors in different banana genotypes. Nova Porteirinha, MG, 2021.

Genotypes	VCPLB	SB	WUSLB	BUS
Prata Gorutuba R1	Green	BSR	AVW	Absent
Prata Gorutuba R2	Green	BSR	AVW	Absent
Prata Gorutuba	Green	BSR	AVW	Absent
Prata-Ana	Green	BSR	AVW	Absent
BRS Princesa	Green	BSA	AVW	Absent

VCPLB: vein color of the lower phase of the leaf blade; SB: Shape of the base of the leaf; WUSLB: Waxiness of the underside of the leaf blade; BUS: Brightness of the upper side of the leaf. BSR: Both sides of the leaf are rounded; BSA: Both sides of the leaf acute; AVW: absent or very weak.

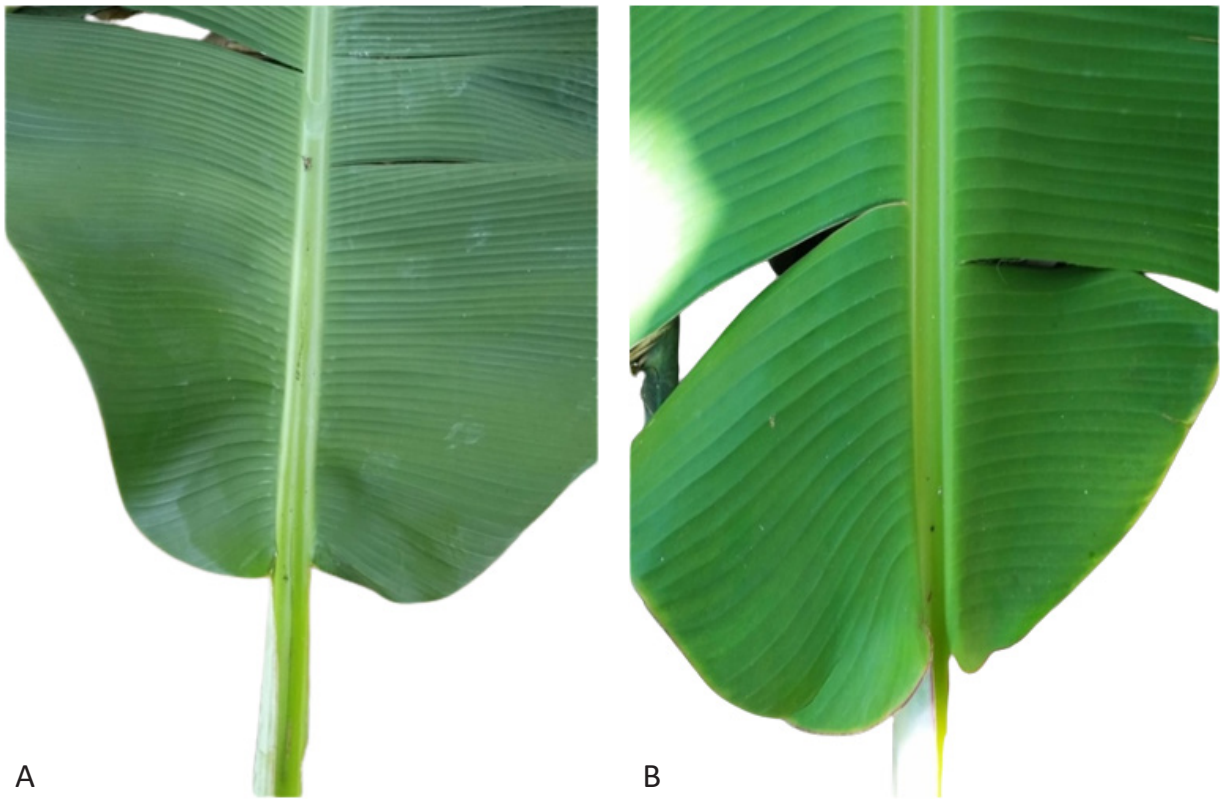

Figure 4. Classification of leaf morphological descriptors: Difference in the shape of the base (FB) of the leaves of banana genotypes (A: Both sides of the leaf rounded B: Both sides of the leaf acute). Nova Porteirinha, MG, 2021. A) Clone-elite Prata Gorutuba R1, B) 'BRS Princesa'.

The evaluated genotypes showed similarities in the results of the evaluations of the banana minimum descriptors. It was observed that the elite clones Prata Gorutuba R1 and R2 showed great similarity with the results of the cultivars Prata Gorutuba, Prata Ana and Princesa. This was evident in the fruit descriptors: (1) curvature characterized by slightly curved, moderate longitudinal edges, (2) apex shape considered bottle neck, (3) green skin color evaluated as light green, (4) skin color mature considered medium yellow, (5) persistence of floral organs, characterized by absence and (6) flesh color characterized as whitish (Table 3, figure 5).

The Grande Naine cultivar had greenish-yellow fruit and persistent floral organs, differing from the other genotypes (Table 3). The presence of the B genome in the genomic groups favors the presence of more angular fruits, less sweet and with an increase in starch content, when ripe (NUNES, 2018). According to Matssura et al. (2004), the consumer preference for banana would be

a fruit with a size between 12 and 15 cm, diameter varying between 26 and 35 mm, good yield of pulp (thin peel), firm pulp, yellowish peel color tending to stronger yellow, pulp color light yellow and medium intensity flavor. The color of the fruits is the main characteristic analyzed by the consumer at the time of purchase and, according to Willset al. (1998) and Caano Chauca (2000), fruit color is also affected by sensory characteristics, being directly associated with the state of fruit maturation.

Table 3. Classification of fruit morphological descriptors in different banana genotypes.. Nova Porteirinha, MG, 2021.

Genotypes	FC	LEF	FAS	SCBM	SCCM	PFO	FPC
Prata Gorutuba R1	SC	Moderates	BN	LG	MY	Absent	Whitish
Prata Gorutuba R2	SC	Moderates	BN	LG	MY	Absent	Whitish
Prata Gorutuba	SC	Moderates	BN	LG	MY	Absent	Whitish
Prata-Ana	SC	Moderates	BN	LG	MY	Absent	Whitish
Grande Naine	SC	Moderates	BN	LG	GY	Present	Whitish
BRS Princesa	SC	Moderates	BN	LG	MY	Absent	Whitish

FC: fruit curvature; LEF: longitudinal edges of the fruit; FAS: fruit apex shape; SCBM: skin color before maturation; SCCM: skin color at consumption maturity; PFO: persistence of floral organs at the apex of the fruit; FPC: fruit pulp color. SC: slightly curved; BN: bottle neck; LG: light green; MY: medium yellow; GY: greenish yellow.

Figure 5. Classification of fruit morphological descriptors: Difference in skin color at consumption maturity (CCMC) of banana genotypes (A: medium yellow, B: greenish yellow).Nova Porteirinha, MG, 2021. A) Clone-elite Prata Gorutuba R2, B) 'Grande Naine'.

For the morphological descriptors of the inflorescence, the cultivars Prata-Ana and BRS Princesa were classified as narrow ovulated in the characteristic shape of the male inflorescence, different from the elite clones Prata Gorutuba R1, Prata Gorutuba R2 and the cultivar Prata Gorutuba, considered medium ovulated. Cultivar BRS Princesa had a wide acute bract apex, differentiating it from the remaining genotypes, which had a straight acute shape (Table 4, figure 6). The morphological descriptors in all evaluated

genotypes showed persistence of the male inflorescence present, the male inflorescence with very open opening of the bracts and the bract with a whitish color on the inner face.

Table 4. Classification of inflorescence morphological descriptors in different banana genotypes. Nova Porteirinha, MG, 2021.

Genotypes	PMI	SMI	OBMI	CISB	BAS
Prata Gorutuba R1	Present	MO	VO	OR	RA
Prata Gorutuba R2	Present	MO	VO	OR	RA
Prata Gorutuba	Present	MO	VO	OR	RA
Prata-Ana	Present	NO	VO	OR	RA
BRS Princesa	Present	NO	VO	OR	WT

PMI: Persistence of male inflorescence; SMI: Shape of the male inflorescence; OBMI: Opening of the bracts of the male inflorescence opening; CISB: Coloration of the inner side of the bracts; BAS: Bract apex shape; MO: Medium oval; NO: Narrow oval; VO: Very open; OR: Orange-red; RA: Right angle; WT: Wide treble.

Figure 6. Classification of inflorescence morphological descriptors: Difference in male inflorescence shape of banana genotypes (IMF) (A: Medium oval, B: Narrow oval). Nova Porteirinha, MG, 2021. A) Clone-elite Prata Gorutuba R2, B) 'BRS Princesa'.

The elite clones Prata Gorutuba R1 and R2 differed from the Grande Naine and BRS Princesa cultivars in several morphological descriptors and resembled the cultivars of the Prata group, which is a very positive aspect, as they demonstrate that they have characteristics that are already widely accepted by the market, with a predominance of cultivation areas with cultivars from the Prata group.

Conclusion

The elite clones Prata Gorutuba R1 and Prata Gorutuba R2 have similar morphological descriptors to the Prata group. Only the descriptors FP: Funneling of the pseudostem and FMI: Format of the male inflorescence showed differences in the results.

The minimum morphological descriptors TP: Tapering of the pseudostem, PCP: Predominant color of the pseudostem, IAS:

Intensity of anthocyanin staining, CLPBS: Color of the lower phase of the basal sheath, CCP: Compactness of the crown of the plant, SB: Shape of the base of the leaf, BCCM: bark color at consumption maturity, PFO: persistence of floral organs at the apex of the fruit, MIFS male inflorescence shape and MISD: male inflorescence shape distinguished the elite clones Prata Gorutuba R1 and Prata Gorutuba R2 from the evaluated cultivars.

There was no distinction in the morphological descriptors between the elite clones Prata Gorutuba R1 and Prata Gorutuba R2.

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