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EVALUATION OF ORNAMENTAL BANANA ACCESSIONS FOR VEGETATIVE PERFORMANCE UNDER GODAVARI ZONE OF ANDHRA PRADESH INDIA

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ABSTRACT

The ornamental market in the Godavari zone of Andhra Pradesh has seen a surge in demand for unique plant species. As a result of this trend, ornamental banana could be one of those unique plant species that can fulfil the need for ornamental market demand in Godavari zone of Andhra Pradesh. This study was conducted during 2023-24, at College of Horticulture, Dr. Y.S.R. Horticultural University, Venkataramannagudem, West Godavari district to evaluate the morphological and physiological parameters of fifteen ornamental banana accessions. Number of suckers per plant recorded highest in Acc.6 (R2-92) at 60, 90, and 150 DAP, at 120 DAP, Acc.14 was observed with high sucker production per plant while the lowest sucker production per plant was observed and recorded in Acc.13 (SR9-3). Total chlorophyll content and amount of anthocyanin content in leaf was recorded highest in Acc.5 (R2-52). Number of living (functional) leaves at flower initiation and harvest were recorded in Acc.11 (SR7-7). Minimum number of living leaves at flower initiation were recorded in Acc.3 (R1-76) and at harvest in Acc.14 (*Musa laterita*). Longest crop duration was recorded in Acc.6 (R2-92) and shortest crop duration in Acc.10 (SR5-15) and Acc.12 (SR8-9).

Keywords **:** Ornamental banana, Accessions, Non-traditional ornamental, Vegetative characters, Andhra Pradesh.

Introduction

The use of non-traditional ornamental crops has been increasing in recent years making development of novel ornamental types as a substitute for various floricultural segments (Janakiram *et al.,* 2021). Ornamental banana offers greater utility in landscaping due to their ornamental beauty with its lush green foliage sometimes variegated with colourful inflorescence. It could be an exotic ornamental crop, which now-a-days getting popularized in the Asian countries and other western countries as well. Ornamental banana belongs to the Musaceae family, Order Zingiberales in which important ornamental crops are *Alpinia purpurata*, *Hedychium spp.*, Siam tulip, *Costus*, *Zinziber spp.*, *Kaempferia*, *Etlingera* etc. The genus *Musa* L. is believed to have originated from South East Asia (Ploetz *et al.,* 2007). It is categorized into five sections (Eumusa, Rhodochlamys, Callimusa, Australimusa, and Ingentimusa) based on the number of chromosomes and morphological characteristics (Stover and Simmonds, 1987). This genus displays significant genetic diversity, encompassing approximately 70 species (Hakkinen and Wallace, 2007) and over 500 cultivars (Valmayor *et al.,* 2000). However, numerous species were still unenlightened for their ornamental value. Although banana have attained the status of the most widely produced, consumed and traded fruit on earth, their ornamental potential has not yet been utterly exploited. The ornamental banana has the ability to add the tropical

effect to the landscape along with vividly coloured blooms produced over weeks or few months (Aparna, 2024). The broad-leaved plants can be categorized for utilization as landscape plants and dwarf statured plants can be used for container planting. The unique climatic and environmental conditions of the Godavari region make it essential to evaluate and characterize these accessions to understand their relative potential for ornamental use. Hence, this study was conducted with a main objective to evaluate morphological characterization and assess the relative potential of ornamental banana accessions for ornamental use under the Godavari zone of Andhra Pradesh.

Materials and Methods

Site and experimental details

The experiment was conducted under open field conditions in College of Horticulture, Dr. Y.S.R. Horticultural University, Venkataramannagudem, West Godavari district, Andhra Pradesh, India. The location falls under 'Agro-climatic Zone-10, humid, East Coast Plain and Hills' (Krishna-Godavari Zone) with an average annual rainfall of 900 mm at an altitude of 34 m (112 feet) above the mean sea level. The experimental site was geographically situated at 16.88º north latitude and 81.45º east longitude with a hot humid summer and mild winter climate. The study included fifteen accessions viz., Acc.1 (R1-8), Acc.2 (R1-11), Acc.3 (R1-76), Acc.4 (R2-9), Acc.5 (R2-52), Acc.6 (R2-92), Acc.7 (MR1-4), Acc.8 (MR2-3), Acc.9 (MR2-7), Acc.10 (SR5-15), Acc.11 (SR7-7), Acc.12 (SR8-9), Acc.13 (SR9-3), Acc.14 (*Musa laterita*) and Acc.15 (*Musa ornata*). Of these, thirteen were interspecific hybrids between *Musa ornata* and *Musa rubra*, *Musa rubra* and *Musa accuminata* subsp. *Zebrina*, *Musa ornata* and *Musa accuminata* subsp. *Zebrina*, and *Musa ornata* and *Musa velutina* and two were ornamental banana species. Planting material was collected from Centre of Excellence for Research and Training in Protected Cultivation, Dr. YSRHU, Venkataramannagudem (Accessions 1-13) and Horticultural Research Station, Kovvur (Accessions 14 & 15). The experiment was laid out in Randomized Block Design with two replications in open-field conditions. Healthy suckers weighing 900-1000g were planted in uniform pits at a spacing of 1.5 m × 1.5 m and all the timely management practices specific to banana were followed.

Measurements

Number of suckers per plant were recorded at 60, 90, 120 and 150 DAP. The total number of healthy(functional) leaves at the time of inflorescence initiation were counted and recorded. The total number of healthy (functional) leaves at harvest (end of male phase) were counted and recorded. Leaf colour on abaxial and adaxial side was determined by using Royal Horticultural Society (RHS) colour chart. The total chlorophyll content of leaves was recorded on fully emerged second leaf using Soil Plant Analysis Development (SPAD) Chlorophyll meter.

The amount of anthocyanin content in leaf and bract was estimated by using UV Spectrophotometer as per the procedure detailed by Das *et al.* (2021).

For measurement of the Anthocyanin, approximately 0.5 g of fresh and matured leaf and bract tissue samples were homogenized by grinding in 20 ml of extracting mixture solution containing propanol-HCl-H_2O (18:1:81 on v/v). The extraction vials or flasks were incubated in boiling water for 1.5 min. The tubes were incubated in dark for 24 h in the extraction medium at 25°C for the complete pigment extraction. Subsequently, extracts were centrifuged for 40 min at about 5000G and supernatant was collected for recording the absorbance (A) at 535nm and 650nm. The absorbance values at 535nm were corrected for scattering (S) using the A values at 650 nm (A650) using Rayleigh's formula. Thus, corrected A535 nm is considered for actual anthocyanin calculation, since there is no or less absorption by anthocyanin at 650 nm (Das *et al*., 2021). Total anthocyanin was calculated using below formulae:

Corrected A535 = A535nm– A650nm.

Anthocyanin (mg 100 g^{-1}) = (Corrected A535) × Volume made up × (1/W) × (1/1000) × 100

Where, W is the weight of fresh leaves taken for extraction, and V is volume of the leaf extract.

Crop duration was determined as total number of days taken from planting to the completion of male phase was recorded.

Result and Discussion

Number of suckers per plant

It is clear from the results (Table 1) obtained that, there is a significant difference in ornamental banana accessions at 60, 120 and 150 DAP concerning the number of suckers per plant. At 60 DAP, maximum number of suckers were produced in Acc.6 (0.50) and Acc.9 (0.50) which was found to be at par with Acc.11 (0.33) while no suckering was observed in Acc.2, Acc.3, Acc.4, Acc.5, Acc.8, Acc.10, Acc.12, Acc.13 and Acc.15 (0.00). Number of suckers per plant in ornamental banana accessions was found significant at 90 DAP. Maximum sucker production was recorded in Acc.6 (2.50) and Acc.14 (2.50) that was found to be at

par Acc.7 (2.17), Acc.10 (1.83), Acc.11 (1.83), Acc.4 (1.83), Acc.5 (1.83), Acc.8 (1.67), Acc.3 (1.50), Acc.9 (1.50), Acc.12 (1.50), Acc.15 (1.67) and minimum sucker production was observed and recorded in Acc.13 (0.17). At 120 DAP, highest number of suckers were produced in Acc.14 (3.50) followed by Acc.3 (2.33) and Acc.6 (2.33) whereas lowest number of suckers were produced in Acc.13 (0.67). Maximum number of suckers at 150 DAP were produced in Acc.6 (3.67) that was found to be at par with Acc.7 (3.00) and Acc.14 (2.83) while minimum suckers were produced in Acc.13 (0.83) which was found to be at par with Acc.3 (1.83) and Acc.5 (1.83).

Table 1 : Number of suckers in ornamental banana accessions in Godavari zone of Andhra Pradesh

Accessions	Number of suckers			
	60 DAP	**90 DAP**	**120 DAP**	**150 DAP**
T1: Acc.1 (R1-8)	0.17 (1.08)	1.17 (1.47)	1.83 (1.68)	2.00 (1.73)
T2: Acc.2 (R1-11)	0.00 (1.00)	1.00 (1.41)	2.00 (1.72)	2.17 (1.77)
T3: Acc.3 (R1-76)	0.00 (1.00)	1.50 (1.58)	2.33 (1.82)	1.83 (1.68)
T4: Acc.4 (R2-9)	0.00 (1.00)	1.83 (1.68)	1.83 (1.68)	2.50 (1.88)
T5: Acc.5 (R2-52)	0.00 (1.00)	1.83 (1.68)	1.83 (1.68)	1.83 (1.68)
T6: Acc.6 (R2-92)	0.50 (1.22)	2.50 (1.88)	2.33 (1.83)	3.67 (2.16)
T7: Acc.7 (MR1-4)	0.17 (1.08)	2.17 (1.77)	1.83 (1.68)	3.00 (2.00)
T8: Acc.8 (MR2-3)	0.00 (1.00)	1.67 (1.63)	1.83 (1.68)	2.00 (1.72)
T9: Acc.9 (MR2-7)	0.50 (1.22)	1.50 (1.58)	1.83 (1.68)	2.50 (1.88)
T10: Acc.10 (SR5-15)	0.00 (1.00)	1.83 (1.68)	2.00 (1.72)	2.17 (1.77)
T11: Acc.11 (SR7-7)	0.33 (1.15)	1.83 (1.68)	2.00 (1.72)	2.17 (1.77)
T12: Acc.12 (SR8-9)	0.00 (1.00)	1.50 (1.58)	1.67 (1.63)	2.50 (1.88)
T13: Acc.13 (SR9-3)	0.00 (1.00)	0.17 (1.08)	0.67 (1.63)	0.83 (1.34)
T14: Acc.14 (*Musa laterita*)	0.33 (1.15)	2.50 (1.88)	3.50 (2.12)	2.83 (1.96)
T15: Acc.15 (*Musa ornata*)	0.00 (1.00)	1.67 (1.63)	1.67 (1.63)	2.17 (1.77)
Mean	**0.13 (1.06)**	**1.64 (1.61)**	**1.94 (1.71)**	**2.28 (1.80)**
SEm±	0.09	0.39	0.26	0.314
CD at 5%	0.12	0.34	0.24	0.29

Values in parenthesis indicate square root transformed values

The results demonstrated high variability for the number of suckers per plant, which may be due to ploidy levels or genomic constitution. Ramajayam *et al.* (2022) observed great variability in number of

suckers per plant among the ornamental banana progeny involving four interspecific crosses (RZ, OR, OZ and OV). Dalawai *et al.* (2017) recorded higher variability for number of suckers per clump among sixteen genotypes of *Heliconia* under shade house conditions. Similarly, Krishna *et al.* (2023) observed superior morphological characteristics in terms of growth and sucker production in *Heliconia vellerigera,* among the eight genotypes evaluated. While, among the forty-one *Heliconia* genotypes, Safeena *et al.* (2023) reported maximum sucker production in *H.* 'Tropics' followed by *H. psittacorum* 'Petra' and *H.* 'Guyana'.

Leaf colour

The abaxial and adaxial colour of the leaf in the accessions of ornamental banana as identified with reference to the RHS colour chart (Table 2 and Figure 1) showed identifiable variations.

On the adaxial side, Accessions 1, 6, 8 (Group 137), 2, 4, 5, 7, 9, 10, 11, 14 (Group 135), 3, 12 (Group138), 15 (Group 139) fall into green coloured group while Acc. 13 falls under yellow-green group (Group 144). Further, banana accessions were categorized into sub-groups based on the leaf colour on the adaxial side where, leaves of Acc.6 (Subgroup A), accessions 1 and 8 (Subgroup B) were in moderate olive-green colour while, accessions 2, 4, 5, 7, 9, 10, 11 and 14 (Subgroup A) showcased dark green coloured leaves whereas moderate yellowish green leaves were found in accessions 3 and 12 (Subgroup A). Dark yellowish green and strong yellow-green were found in Acc.15 (Subgroup A) and Acc.13 (Subgroup B) respectively.

On the abaxial side of the leaf, there was a great visual variation in leaf colour which is not commonly observed in a cultivated banana plant. Accessions 3, 11 (Group 137), 10, 14 (Group 138), 15 (Group N138), 12 (Group 139) and 13 (Group 142) were green in colour.

Table 2 : Leaf colour of ornamental banana accessions in Godavari zone of Andhra Pradesh

Accessions	Adaxial side			Abaxial side		
	Colour code	Colour Group	Name	Colour code	Colour Group	Name
T1: Acc.1 (R1-8)	137B	Green	Moderate Olive green	N77A	Purple	Greyish Purple
T2: Acc.2 (R1-11)	135A	Green	Dark Green	N77A	Purple	Greyish Purple
T3: Acc.3 (R1-76)	138A	Green	Moderate Yellowish Green	137B	Green	Moderate Olive green
T4: Acc.4 (R2-9)	135A	Green	Dark Green	N77A	Purple	Greyish Purple
T5: Acc.5 (R2-52)	135A	Green	Dark Green	N77A	Purple	Greyish Purple
T6: Acc.6 (R2-92)	137A	Green	Moderate Olive green	200C	Grey-Brown	Moderate Brown
T7: Acc.7 (MR1-4)	135A	Green	Dark Green	200B	Grey-Brown	Greyish Reddish Brown
T8: Acc.8 (MR2-3)	137B	Green	Moderate Olive green	N77A	Purple	Greyish Purple
T9: Acc.9 (MR2-7)	135A	Green	Dark Green	166A	Greyed-orange	Greyish Brown
T10: Acc.10 (SR5-15)	135A	Green	Dark Green	138A	Green	Moderate Yellowish Green
T11: Acc.11 (SR7-7)	135A	Green	Dark Green	137B	Green	Moderate Olive green
T12: Acc.12 (SR8-9)	138A	Green	Moderate Yellowish Green	139D	Green	Moderate Yellowish Green
T13: Acc.13 (SR9-3)	144B	Yellow-Green	Strong Yellow Green	142C	Green	Light Yellow Green
T14: Acc.14 (*Musa laterita*)	135A	Green	Dark Green	138B	Green	Moderate Yellowish Green
T15: Acc.15 (*Musa ornata*)	139A	Green	Dark Yellowish Green	N138B	Green	Moderate Yellowish Green

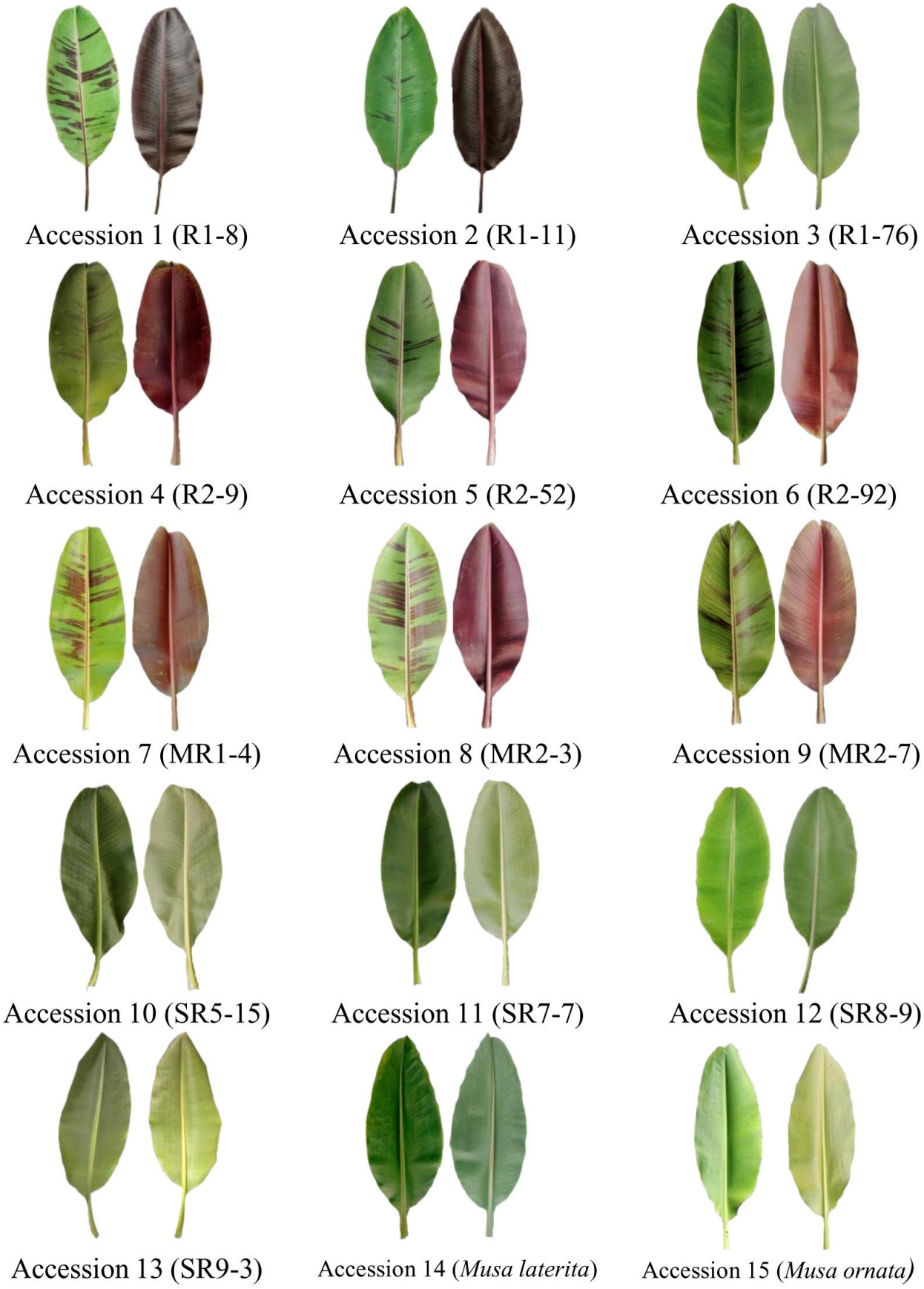

Fig. 1 : Leaf colour variations on adaxial and abaxial in ornamental banana accessions

While greyish brown colour on the abaxial side of the leaf was noticed in accessions 6 and 7 (Group 200) whereas greyish orange was observed in Acc.9 (Group 166). Purple colour on the underside of the leaf was observed in accessions 1, 2, 4, 5 and 8 (Group N77). Nevertheless, when grouping the leaves based on leaf colour on the abaxial surface of the leaf, Accessions 1, 2, 4, 5 and 8 (Subgroup A) were greyish purple whereas greyish brown was found in Acc.9 (Subgroup A). Moderate brown and greyish reddish-brown colour on the abaxial surface of the leaf was noticed in accessions 6 (Subgroup C) and 7 (Subgroup B) correspondingly. Moderate olive green was found in accessions 3 and 11 (Subgroup B) whereas moderate yellowish green was noticed in accessions 10 (Subgroup A), 12 (Subgroup D), 14 (Subgroup B) and 15 (Subgroup B), while light yellow green colour on the underside of the leaf was found in Acc.13 (Subgroup C).

The leaf colour and variegations on the abaxial and adaxial surfaces are important attributes in ornamental plants, which stands out in ornamental banana accessions in this regard. Ramajayam *et al.* (2020) evaluated 362 ornamental banana F_1hybrids involving four interspecific crosses (RZ, OR, OZ, and OV) in the open field conditions and observed great variability in leaf colour among the progeny. Castro *et al*. (2018) ascertained the morpho phenological characterization of ten ornamental ginger accessions and observed a large variation in leaf colour.

Number of living (functional) leaves at flower initiation

It could be apparently concluded that there was a significant difference among the accessions for number of living (functional) leaves at flower initiation and at harvest (Table 3).

More number of leaves at the flower initiation was recorded in Acc. 11 (12.67) while lowest number of leaves at flower initiation was recorded in Acc. 3 (9.50) that was found to be at par with Acc.9 (9.67), Acc.13 (9.67), Acc.5 (9.84), Acc.15 (10.00), Acc.10 (10.17), Acc.8 (10.50), Acc.6 (10.50), Acc.1 (10.67) and Acc.4 (10.67).

Number of living (functional) leaves at harvest

Maximum number of leaves retained on plant at harvest was recorded in Acc.11 (9.84) followed by Acc.7 (8.00) whereas, minimum number of living leaves at harvest was observed in Acc.14 (3.67) which was at par with Acc.13 (5.00).

The results are in congruity with Santos-Serejo *et al.* (2012) in ornamental banana hybrids and Pereira *et al.* (2005) in ornamental taro. Nayak *et al.* (2020) reported similar findings in a study on vegetative characterization of five banana genotypes and revealed that the maximum number of functional leaves at inflorescence emergence was observed in NRCB Selection-10 while minimum was in Nendran genotype. Dagnew *et al.* (2021) recorded maximum number of functional leaves per plant (13.3) in banana cv. Ambo-3 and minimum number of functional leaves per plant (11.5) in cv. Lady Finger. It may be attributed to the genetic potential of the plants and environmental factors such as climate and nutrient availability.

As banana belongs to monocarpic growth category, in which vegetative phase seizes after initiation of reproductive phase. For an ornamental plant, it is good when it remains attractive at end of male phase as well, which possibly fulfilled when more leaves retain on the plant at harvest. In the present study, for the variable, number of leaves, it was observed, on average, eleven leaves at the flower initiation and seven leaves at harvest. These values are considered desirable for ornamental plants since this number impacts densification, which is an intriguing component for landscaping or even for potted plants.

Total chlorophyll content (SPAD)

The data presented in Table 3 showed significant difference in total chlorophyll content (SPAD) of leaves in ornamental banana accessions.

Maximum total chlorophyll content was recorded in Acc. 5 (59.05 SPAD) which was found to be at par with Acc. 11 (58.35 SPAD), Acc. 8 (58.25 SPAD), Acc.7 (57.30 SPAD), Acc.12 (56.55 SPAD), Acc.4 (55.40 SPAD), Acc.9 (55.20 SPAD), Acc.3 (54.85 SPAD) and Acc.10 (53.45 SPAD) whereas minimum total chlorophyll content was recorded in Acc. 14 (48.10 SPAD).

Significant differences in relative chlorophyll content of two ornamental banana varieties viz., *Musa* 'Little Prince' and Musa 'Truly Tiny' were shown by Vendrame *et al.* (2022). Further they attributed the differential responses to genotype effect.

Table-3. Quantitative and physiological descriptors of ornamental banana in Godavari zone of Andhra Pradesh

Accessions	NLFI	NLH	CHL	ANL	CRD
T1: Acc.1 (R1-8)	10.67	7.17	51.90	24.85	225.67
T2: Acc.2 (R1-11)	11.00	7.00	49.85	34.15	217.17
T3: Acc.3 (R1-76)	9.50	6.83	54.85	0.05	224.83
T4: Acc.4 (R2-9)	10.67	7.50	55.40	36.75	230.00
T5: Acc.5 (R2-52)	9.84	7.83	59.05	40.75	225.33
T6: Acc.6 (R2-92)	10.50	6.67	50.40	24.35	263.83
T7: Acc.7 (MR1-4)	11.34	8.00	57.30	23.80	254.67
T8: Acc.8 (MR2-3)	10.50	6.50	58.25	30.90	233.00
T9: Acc.9 (MR2-7)	9.67	6.50	55.20	22.60	240.83
T10: Acc.10 (SR5-15)	10.17	7.50	53.45	0.03	191.50
T11: Acc.11 (SR7-7)	12.67	9.84	58.35	0.04	214.83
T12: Acc.12 (SR8-9)	11.17	6.00	56.55	0.05	191.50
T13: Acc.13 (SR9-3)	9.67	5.00	48.70	0.02	233.00
T14: Acc.14 (*Musa laterita*)	11.00	3.67	48.10	0.02	197.50
T15: Acc.15 (*Musa ornata*)	10.00	5.50	50.75	0.05	208.67
Mean	**10.56**	**6.77**	**53.87**	**15.89**	**223.49**
SEm±	0.42	0.45	1.88	1.47	5.01
CD at 5%	1.28	1.36	5.70	4.46	15.21

NLFI: Number of living (functional) leaves at flower initiation; NLH: Number of (functional) leaves at harvest; CHL: Total chlorophyll content (SPAD); ANL: Anthocyanin content in leaf (mg $100g^{-1}$) and CRD: Crop duration (days)

Anthocyanin content in leaf (mg 100 g^{-1})

Table 3 represents the data regarding anthocyanin content in leaf and bract with a significant variance.

Highest amount of anthocyanin content in leaf was found in Acc.5 (40.75 mg 100 g^{-1}) which was found to be at par with Acc.4 (36.75 mg 100 g^{-1}) while, Acc.13 and Acc.10 recorded the lowest anthocyanin content (0.02 mg 100 g^{-1}) and were found to be at par with Acc.14 (0.03 mg 100 g^{-1}), Acc.11 (0.04 mg 100 g^{-1}), Acc.15 (0.05 mg 100 g^{-1}), Acc.12 (0.05 mg 100 g^{-1}) and Acc.3 (0.05 mg 100 g^{-1}).

The results are in line with findings of Malakar *et al.* (2015) in leaves of heliconia genotypes. Identical findings were reported by Ramajayam *et al.* (2024) in ornamental banana species and hybrids and confirmed that Ant-FH-SSR11, a genic SSR marker that was identified from the F35H-1 gene present in the anthocyanin pathway was capable of differentiating the hybrids & species and their progeny. Similarly, another marker, 430-SSR, was also able to differentiate coloured parent (*Musa acuminata* subsp. *zebrina*) from other ornamental green parents and their hybrids.

Crop duration (From planting to end of male phase) (days)

From the data presented in Table 3, it is evident that there was a significant variation among the accessions in days taken from planting to end of male phase.

Shortest duration from planting to end of male phase was recorded in Acc.10 (191.50 days) and Acc.12 (191.50 days) which were at par with Acc.14 (197.50 days). Longest crop duration was observed in Acc.6 (263.83 days) which was found to be at par with Acc.7 (254.67 days). The mean average for crop duration was 223.49 days.

The variation in crop duration might be due to the influence of various factors such as early inflorescence emergence, number of bracts, bract longevity and genetic factors. The shortest duration from planting to end of male phase as recorded in accessions 12, 10 and 14 unveils the plant precocity and is an important character in ornamental banana breeding.

Conclusion

Number of suckers per plant recorded highest in Acc.6 (R2-92) at 60, 90, and 150 DAP, at 120 DAP, Acc.14 was observed with high sucker production per plant while the lowest sucker production per plant was observed and recorded in Acc.13 (SR9-3). Total chlorophyll content and amount of anthocyanin content in leaf was recorded highest in Acc.5 (R2-52). Rich in leaf pigments ensures their use as cut foliage. Number of living (functional) leaves at flower initiation and harvest were recorded in Acc.11 (SR7-7), which qualifies the accession as a potted plant and for landscaping purposes. Minimum number of living leaves at flower initiation were recorded in Acc.3 (R1-

76) and at harvest in Acc.14 (*Musa laterita*). Longest crop duration was recorded in Acc.6 (R2-92) and shortest crop duration in Acc.10 (SR5-15) and Acc.12 (SR8-9).

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