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Genetic Variability of Banana (*Musa* spp.) in West Coastal Zone of India

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Abstract The investigation was carried out to assess growth and yield performance of thirty banana genotypes along with the extent of genetic variation found in West Coastal Zone of India among fourteen characters, all of which had shown substantial variation. PCV was found greater than GCV for all characters. High heritability in broad sense (h^2b) coupled with high genetic advance (GAM) was noticed for number of living leaves at harvest and fruit peel thickness indicating role of additive gene action. The important yield characters viz., bunch and fruit weight with high PCV, GCV, heritability and moderate to high GAM were proved as the prime selection criteria. The genomic group AAA was found better than others. The genotypes Pache Bontha Bathesa (ABB) and Udhayam (ABB) were found high yielding but considering quality characters, Grand Naine (AAA) was found as the best in ecological conditions of the West Coastal Zone of India.

Keywords Banana, Genetic variability, Heritability, Genetic advance, Genotypic and Phenotypic coefficient of variation.

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Introduction

Banana (*Musa* spp.) is the second most important fruit crop in India next to mango. Botanically bananas are the kinds of large herbaceous perennial monocot flowering plants of the genus *Musa* belonging to the family Musaceae of order Scitamineae. Although the Konkan area is untraditional to the banana crop, however some pockets are developing to cultivate bananas as a cash crop where irrigation facilities are available. Through breeding strategies, we have to develop improved genotypes and populations and select better cultivars with high and stable yield, improved agronomic traits, superior fruit quality and improved keeping quality also. The success of any breeding program depends upon the quantum of genetic variability available for exploitation. Hence, the present investigation was laid out to assess growth and yield performance of thirty banana genotypes and also to study the extent of genetic variation in West Coastal Zone of India.

Materials and Methods

The experiment was conducted at Central Experimental Station, Wakawali at Tetawali, Tal-Dapoli, Dist–Ratnagiri of Maharashtra. Konkan region is located at Western side of India having area of about 30,000 sq km adjoining to Arabian Sea. The germplasm material comprising of 30 genotypes of banana and plantains (shown in Table 1) had been collected from the National Research Center for Banana (NRCB), Trichy, Tamilnadu and planted at the experimental block on

Table 1. Mean performances of different parameters of banana genotypes.

Sl. No.	Name of genotype	Genomic group	Pseudostem height (m)	Leaf blade length (cm)	Leaf blade width (cm)	No. of living leaves at harvest	Peduncle length (cm)	No. of hands	No. of fruits per hand
1	Anai Komban	AA	2.18	166.43	54.63	5.67	21.17	5.00	13.67
2	Kanai Bansi	AA	2.74	198.00	69.07	5.00	34.70	6.00	16.67
3	Dwarf Cavendish	AAA	1.54	137.23	64.30	4.33	29.77	8.00	21.33
4	Grand Naine	AAA	1.97	177.23	71.90	4.00	34.80	9.00	22.00
5	Robusta	AAA	2.40	182.73	77.70	5.33	32.43	8.00	18.33
6	Amrit Sagar	AAA	2.23	214.57	81.37	5.00	37.23	6.00	12.33
7	Red Banana	AAA	3.89	283.53	83.30	5.00	35.10	7.00	14.00
8	Jwari Bale	AAB	1.82	152.90	90.67	4.67	27.27	6.67	12.67
9	Nendran	AAB	2.84	185.97	63.70	4.67	30.13	5.00	9.67
10	Poovan	AAB	2.88	188.63	63.77	6.00	44.60	12.00	14.33
11	Pacheladan	AAB	2.89	187.63	46.10	3.67	45.73	8.33	13.67
12	Malaikali	AAB	3.23	273.17	79.80	5.00	28.87	7.00	14.00
13	Ladan Pointed	AAB	3.44	241.57	66.17	4.67	35.10	8.00	14.00
14	Nendra Padathi	AAB	3.17	201.03	66.57	3.00	37.43	7.00	12.33
15	Sabri	AAB	3.08	260.03	66.00	4.00	28.53	6.67	13.33
16	Kunnan	AB	2.47	210.63	67.77	4.33	26.43	7.00	14.33
17	Ney Poovan	AB	2.95	159.53	53.53	6.33	24.40	9.00	16.00
18	Karpuravalli	ABB	4.86	182.87	63.23	5.33	40.90	8.33	13.67
19	Peyan	ABB	4.25	240.03	68.17	4.00	27.37	6.33	16.67
20	Udhayam	ABB	4.33	240.33	60.97	7.33	44.63	14.33	17.67
21	Ankur II	ABB	4.53	187.90	60.53	7.67	37.80	8.00	13.00
22	Kachkel	ABB	4.11	219.70	61.67	1.67	44.57	6.00	13.33
23	Bangrier	ABB	3.23	249.57	69.17	3.00	30.40	8.00	14.00
24	Kothia	ABB	3.66	214.33	81.03	2.00	33.17	11.00	15.00
25	Saba	ABB	4.44	249.87	72.13	2.33	33.13	6.00	13.00
26	Nutepong	ABB	3.41	248.93	75.17	1.00	39.93	7.33	13.33
27	Pache Bontha Bathesa	ABB	3.28	194.73	66.50	0.67	45.63	12.33	12.00
28	Ashy Bathesa	ABB	3.57	208.10	67.00	0.67	53.77	12.00	12.67
29	Birbutia	ABB	3.33	221.80	83.83	1.33	59.57	9.00	16.67
30	*Musa balbisiana*	BB	4.92	165.27	72.37	8.33	32.63	9.00	14.00
	General mean		3.25	208.14	68.94	4.20	35.91	8.11	14.59
	Range	Min	1.54	137.23	46.10	0.67	21.17	5.00	9.67
		Max	4.92	283.53	90.67	8.33	59.57	14.33	22.00
	SE±		0.089	1.680	0.970	0.310	2.015	0.205	0.660
	CD at 5%		0.252	4.755	2.745	0.878	4.704	0.580	1.867

Table 1. Continued.

Sl. No.	Name of genotype	Fruit length (cm)	Fruit diameter (mm)	Fruit peel thickness (mm)	Bunch weight (kg)	Fruit weight (g)	Flesh texture	Predominant taste
1	Anai Komban	12.27	30.33	1.17	6.33	91.27	Soft	Sweet and acidic
2	Kanai Bansi	16.93	36.33	2.00	9.73	100.47	Soft	Slightly tasty
3	Dwarf Cavendish	12.47	34.33	1.33	20.80	121.43	Soft	Sweet

Table 1. Continued.

Sl. No.	Name of genotype	Fruit length (cm)	Fruit diameter (mm)	Fruit peel thickness (mm)	Bunch weight (kg)	Fruit weight (g)	Flesh texture	Predominant taste
4	Grand Naine	14.93	38.33	2.00	26.40	131.30	Soft	Sweet
5	Robusta	18.63	39.33	0.50	24.10	165.03	Firm	Sweet
6	Amrit Sagar	14.40	40.67	1.00	11.73	161.00	Soft	Sweet
7	Red Banana	14.33	45.67	4.00	20.73	219.13	Soft	Sweet
8	Jwari Bale	14.77	40.67	3.00	12.07	140.20	Soft	Slightly tasty
9	Nendran	16.83	42.33	1.33	11.30	218.07	Firm	Slightly tasty
10	Poovan	11.13	39.67	2.00	14.87	82.63	Firm	Sweet and acidic
11	Pacheladan	13.73	36.67	3.00	12.93	110.33	Firm	Sweet and acidic
12	Malaikali	13.37	37.00	3.00	12.87	130.57	Soft	Sweet and acidic
13	Ladan Pointed	15.60	32.33	4.00	16.63	150.65	Soft	Sweet and acidic
14	Nendra Padathi	13.43	39.67	3.33	16.63	190.97	Soft	Sweet and acidic
15	Sabri	13.80	45.33	2.00	16.10	181.10	Soft	Sugary
16	Kunnan	12.70	42.67	0.67	13.93	137.93	Firm	Sweet
17	Ney Poovan	10.53	33.67	0.50	11.60	76.53	Firm	Sweet
18	Karpuravalli	14.17	39.67	2.00	17.27	146.47	Firm	Sugary
19	Peyan	11.73	36.67	3.00	9.07	82.90	Firm	Slightly tasty
20	Udhayam	15.37	35.00	2.00	30.47	118.30	Firm	Sweet and acidic
21	Ankur II	15.27	37.33	3.00	12.50	111.70	Firm	Sweet and acidic
22	Kachkel	14.80	51.67	3.00	19.30	240.37	Firm	Sweet and acidic
23	Bangrier	18.80	41.00	4.00	27.50	238.57	Firm	Tasteless
24	Kothia	15.33	42.67	3.00	29.03	174.50	Soft	Sweet and acidic
25	Saba	19.60	43.67	4.00	22.17	277.57	Firm	Slightly tasty
26	Nutepong	18.93	55.00	4.00	19.37	202.17	Soft	Sweet
27	Pache Bontha Bathesa	15.17	41.67	4.00	32.87	220.07	Soft	Sweet
28	Ashy Bathesa	13.57	43.33	4.00	27.67	175.10	Soft	Sweet
29	Birbutia	15.50	39.33	3.33	29.37	199.90	Soft	Slightly tasty
30	*Musa balbisiana*	10.50	49.33	1.00	21.30	167.43	Soft	Sweet
	General mean	14.62	40.38	2.51	18.55	158.79		
	Range	10.50	30.33	0.50	6.33	76.53		
		19.60	55.00	4.00	32.87	277.57		
	SE±	0.417	0.658	0.090	1.029	7.606		
	CD at 5%	1.181	1.862	0.253	2.914	21.532		

February 22, 2012 at a spacing of 2.5 m×2.5 m. Among total of 180 plants (6 of each genotype), observations regarding growth, yield and yield attributing parameters were recorded on 3 plants of each genotype. The crop was raised successfully by adopting recommended cultural practices. The data on twelve characters were subjected to statistical analysis commonly applicable to the randomized block design. The phenotypic, genotypic and environmental variances, PCV and GCV, heritability and GAM were estimated.

Results and Discussion

In present experiment, the thirty genotypes of banana exhibited wide range of variation for all the fourteen characters. The mean performances and range of variability of thirty genotypes of banana for twelve quantitative characters and also the variation in two qualitative characters are presented in Table 1. The analysis of variance showed that the differences among the genotypes were highly significant for all the characters. This indicated that, the choice of the genotypes was appropriate and that the genotypes were quite distinct from each other with respect to the characters under study and hence, suitable for genetical analysis.

Regarding the Pseudostem height, the most dwarf genotype Dwarf Cavendish (AAA) with 1.54 m height was found significantly shorter than all the

other genotypes. The tallest height of 4.92 m was recorded by the wild genotype *Musa balbisiana* (BB). The genomic group ABB had the genotypes with somewhat taller stature. The longest leaf blade length was recorded by Red Banana (AAA) (283.53 cm) while the widest leaves (90.67 cm) withheld by Jwari Bale (AAB). Considerable variability was observed in mean number of living leaves at harvest ranging from 0.67 [Pache Bontha Bathesa (ABB)] and Ashy Bathesa (ABB) to 8.33 (*Musa balbisiana*). Lessa et al. [1] also reported such a wide range of variation in this character. Peduncle length varied considerably ranging from 21.17 cm [Anai Komban (AA)] to 59.57 cm [Birbutia (ABB)]. Brandao et al. [2] also reported wide range of variability for peduncle length. The character number of hands per bunch had shown wide variability in the range starting from 5.00 up to 14.33 recorded by Udhayam (ABB) proving to be superior for this character than all the other genotypes. Number of fruits per hand ranged from 9.67 [Nendran (AAB)] to 22.00 [Grand Naine (AAA)] which is in conformity with the earlier findings [3—7]. The genotypes Grand Naine (AAA) and Dwarf. Cavendish (AAA) were found to be the outstanding for this character.

Saba (ABB) recorded longest fruit length (19.60 cm) while Nutepong (ABB) was found the widest (55.00 mm) fruit among all. Fruit peel thickness also recorded considerable variability with Red Banana (AAA) having the thickest peel (4.00 mm) and Ney Poovan (AB) having the thinnest peel (0.50 mm). This is also supported by the findings of Brandao et al. [2] and Gibert et al.[8]. The most prime yield character bunch weight recorded a wide range of variability starting from 6.33 kg [Anai Komban (AA)] up to 32.87 kg [Pache Bontha Bathesa (ABB)] which is closely followed by Udhayam (ABB). Fruit weight also varied over a wide range from 76.53 g [Ney Poovan (AB)] to 277.57 g [Saba (ABB)].

Both firm and soft texture types were found in the present study which were also reported by Brandao et al. [2] and Onyango et al. [9]. Considerable variation was found with respect to the predominant taste like mild or slightly tasty or tasteless, sweet, sugary and sweet and acidic. None of the genotype has shown astringent or any other type of taste. All the types of tastes were reported by Onyango et al. [9] and Rodrigues et al. [10].

Among the all, the genomic group AAA was found with many good characteristic combinations viz. short stature, heavy bunches, good quality fruits with sweet and soft pulp. Genotypes from AB genomic group viz. Kunnan and Ney Poovan were also found with the good quality fruits sweet in taste, small in size but yielding somewhat less heavier bunches. Most of the genotypes in AA and AAB genomic group could be preferred for their characteristic sweet and acidic taste accompanied with optimum bunch weight. The genomic group ABB was found with somewhat mixtures of genotypes, some yielding high with heavier bunches, some having optimum to large fruit size while other having fruits of good quality. Some genotypes had shown sweet taste with soft texture, some showed sweet with firm texture, some were slightly tasty while one viz. Bangrier was found tasteless.

The estimates of PCV and GCV are given in Table 2. In general, PCV was greater in magnitude than GCV. Number of living leaves at harvest (48.78%), fruit peel thickness (47.58%) recorded the highest PCV. In case of GCV, fruit peel thickness (47.18%) and number of living leaves at harvest (47.07) recorded comparatively higher GCV whereas the least estimates were shown by leaf blade width (14.08%) and fruit diameter (13.38%). The estimates of heritability in broad sense (h^2b) and genetic advance along with GAM are also presented in Table 2 and depicted in Figure 1. The heritability ranged from 83.32 to 99.38%. All the twelve quantitative characters showed considerably higher amount of heritability. Leaf blade length recorded the highest amount of heritability (99.38%) followed by fruit peel thickness (98.31%). The genetic advance ranged between 1.80 for Pseudostem height to 103.92 for fruit weight. However, GAM ranged from 26.96% (fruit diameter) to 96.36% (fruit peel thickness). The character like fruit peel thickness (96.36%) showed highest estimates of GAM followed by number of living leaves at harvest (93.57%). While, the lowest estimates of GAM were recorded for leaf blade width (28.57%) and fruit diameter (26.96%).

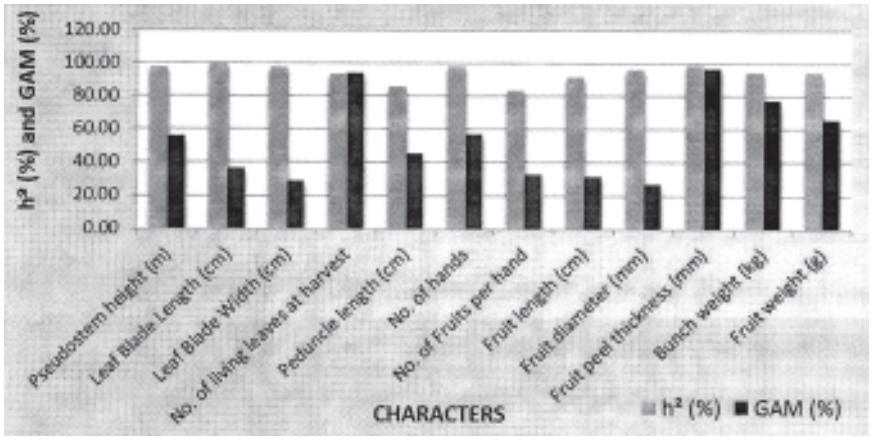

Fig. 1. Heritability (h^2) and genetic advance (GAM) for the twelve characters.

Moderate values of PCV and GCV and very high heritability with moderate GAM was observed for pseudostem height, peduncle length and number of hands per bunch revealing relatively low influence of environment on these traits indicating probability of improvement via selection. This is in accordance with the findings reported by Kavitha et al. [3] and Rajamanickam and Rajmohan [4]. Leaf blade length, leaf blade width, number of fruits per hand, fruit length and fruit diameter shown comparatively lower PCV and GCV with also the least difference between them indicating maximum reflection of genotype into phenotypic expression of these characters. It indicated that these characters are very little prone to the environmental changes. These characters had shown high heritability values with lower GAM indicating the heritability might be due to non-additive gene effects reflecting favorable influence of environment rather than genotype. This indicated that, the simple selection may not be rewarding for these characters. This is in total agreement with the findings of Rajamanickam and Rajmohan [4] and Baruah et al. [11]. The high PCV and GCV with also a very high heritability and GAM were observed for number of living leaves at harvest and fruit peel thickness indicating preponderance of additive gene action and more effectiveness of simple directional selection for improvement.

The most prime yield characters viz. bunch

Table 2. Estimates of genetic parameters for twelve characters in banana.

Sl. No.	Characters	PCV (%)	GCV (%)	h^2 (%)	GA	GAM (%)
1	Pseudostem height (mm)	27.65	27.25	97.07	1.80	55.30
2	Leaf Blade Length (cm)	17.79	17.73	99.38	75.81	36.42
3	Leaf Blade Width (cm)	14.29	14.08	97.09	19.70	28.57
4	No. of living leaves at harvest	48.78	47.07	93.13	3.93	93.57
5	Peduncle length (cm)	25.42	23.48	85.37	16.05	44.70
6	No. of hands	28.13	27.79	97.58	4.59	56.54
7	No. of Fruits per hand	19.18	17.50	83.32	4.80	32.91
8	Fruit length (cm)	16.80	16.05	91.35	4.62	31.61
9	Fruit diameter (mm)	13.67	13.38	95.74	10.89	26.96
10	Fruit peel thickness (mm)	47.58	47.18	98.31	2.41	96.36
11	Bunch weight (kg)	39.76	38.59	94.16	14.31	77.13
12	Fruit weight (g)	33.81	32.77	93.98	103.92	65.44

weight and fruit weight recorded a high estimates of PCV, GCV with also a very high amount of heritability and moderate to high GAM revealing relatively low influence of environment on the traits proving themselves as prime selection criteria for improvement in banana. This is in accordance with the findings of Kavitha et al. [3] and Rajamanickam and Rajmohan [4].

Conclusion

Among all genomic groups, the genomic group AAA was found with many good characteristics combined. The most high yielding genotypes found in the present study were Pache Bontha Bathesa, followed by Udhayam. But considering yield along with the quality characters viz. sweetness, soft pulp texture and dwarfism, the genotype Grand Naine AAA (26.40 kg) was found to be the best in the ecological conditions of the West Coastal Zone of India and could be recommended for cultivation. Among the culinary genotypes having mild taste and more firm texture, Nendran was found as the best. In general, PCV was found greater than GCV for all characters. High heritability in broad sense (h^2b) coupled with high GAM was noticed for character number of living leaves at harvest and fruit peel thickness (mm) indicating role of additive gene action. The most important yield characters bunch weight (kg) and fruit weight (g) with high estimates of PCV, GCV, heritability and moderate to high GAM proved to be the prime selection criteria for improvement in banana.

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