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GENETIC ANALYSIS OF YIELD IN BANANA

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Abstract: The forty eight banana varieties showed significant differences with reference to the 18 characters studied and a large portion of variability in all the characters except length of individual finger was due to genetic factors. Out of 17 characters studied, 13 showed strong correlation with bunch weight. Heritability estimates in the broad sense was high (over 80%) for eleven components and moderately high (65 to 80%) for all the rest except length of individual finger. Genetic gain was highest for weight of individual finger which recorded maximum direct effect on bunch weight. Characters like total number of fingers per bunch, number of hands per bunch, bunch length and girth at the base of pseudostem at shooting time have positive direct effect on bunch weight while, girth of individual finger, total number of leaves per plant and leaf area contributed mainly through other characters. Selection index formulated using characters such as bunch weight, number of hands per bunch, bunch length, total number of fingers per bunch and weight of individual finger was the most effective.

INTRODUCTION

Yield in any crop plant is a complex character determined by a number of genetic factors and environmental conditions occurring at various stages of growth of the plant. Hence, selection for yield merely on the basis of its phenotypic expression is likely to give misleading results. Effectiveness of selection based on phenotypic performance can be more useful and reliable only if selection is based on heritability estimates along with genetic gain. Correlation studies will help in predicting growth and yield performance. Association of yield with its component characters is of immense value in the selection of superior genotypes. Above all these, knowledge of the extent of variability in the germplasm is an essential pre-requisite in any breeding programme.

MATERIALS AND METHODS

This study was conducted at the Banana Research Station, Kannara utilising 48 varieties (Table 1) of diverse origin. A field experiment was conducted utilising the 48 varieties in a randomised block design with three replications. Planting was done in pits of size 50 x 50 x 50 cm with five plants in each variety adopting a spacing of 2.15 m either way. The management practices recommended for banana (KAU, 1981) were strictly adhered to. Observations on ten plant characters and eight bunch characters were recorded from all the plants and means worked out (Table 2). The data were statistically analysed following Fisher (1954) and the genetic parameters were worked out following Burton (1952).

RESULTS AND DISCUSSION

The forty eight banana varieties showed significant differences with reference to the 18 characters studied. Estimates of variance have shown that total observed variances in 17 out of 18 characters studied are mainly due to genetic causes as indicated by a higher magnitude of genotypic variance than environmental variance (Table 2). In the case of length of individual finger alone, the environmental variance exceeded genotypic variance indicating that the expression of this character is highly influenced by the environment. This is in conformity with the findings of Nayar *et al.* (1979) in the case of dessert type bananas. Characters like width of petiole canal, weight of individual finger, total number of fingers per bunch and bunch weight have very high estimates of

Table 1. List of the varieties with their genomic constitution and country of origin

Sl.No.	Name of the variety	Genomic group	Country of origin
1	Pisang Lilin	AA	Malaya
2	Namarai	AA	-
3	Ambalakadali	AB	-
4	Chakkarakadali	AB	-
5	Ney Poovan	AB	South India
6	Njalipoovan	AB	-
7	Adukkan	AB	-
8	Kunnan	AB	South India
9	Adakka Kunnan	AB	South India
10	Poocha Kunnan	AB	South India
11	Valiya Kunnan	AB	South India
12	Nendra Kunnan	AB	South India
13	Thaen Kunnan	AB	South India
14	Vamanakeli	AAA	-
15	Robusta	AAA	Guatemala
16	Mauritius	AAA	-
17	Dwarf Cavendish	AAA	Southern China
18	Nallachakkarakeli	AAA	-
19	Gros Michel	AAA	-
20	Manoranjitham	AAA	-
21	Karimkadali	AAB	-
22	Pacha Chingan	AAB	-
23	H.135 (hybrid)	AAB	South India
24	Padalimoongil	AAB	South India
25	Palayankodan	AAB	South India
26	Mannan	AAB	-
27	Vannan	AAB	South India
28	Nendravannan	AAB	-
29	Pachanaadan	AAB	South India
30	Sirumalai	AAB	South India
31	Virupakshi	AAB	South India
32	Mota Poovan	AAB	South India
33	Suwandel	AAB	-
34	Lady's finger	AAB	South India
35	Nendran	AAB	South India
36	Mulanthuruthy Nendran	AAB	South India
37	Changanassery Nendran	AAB	South India
38	Cheenabale	-	-
39	Bugnan		-
40	Dakshinsagar	AAB	-
41	Kanchikela	ABB	-
42	Pey Kunnan	ABB	Indo China
43	Pisang Awak	ABB	-
44	Peyan	ABB	-
45	Karpooravalli	ABB	-
46	Ennabenian	ABB	-
47	Kapook	ABB	-
48	Kosthabontha	ABB	Indo China

Table 2. Variance and coefficients of variation in 48 varieties of banana

Sl. No.	Characters	Phenotypic variance (VP)	Genotypic variance (Vg)	Environmental variance (Ve)	Phenotypic variation (PCV)	Genotypic variation (GCV)	Environmental variation (ECV)
1	Height of pseudostem at shooting time (cm)	4184.22	3547.48	636.73	21.00	19.34	8.19
2	Girth at the base of pseudostem at shooting time (cm)	99.27	81.16	18.11	15.07	13.63	6.4
3	Number of leaves per plant at shooting time	6.84	4.88	1.96	16.39	13.85	8.79
4	Total number of leaves per plant	14.08	11.03	3.05	11.66	10.32	5.43
5	Leaf area (m^2)	0.09	0.07	0.03	25.51	21.71	11.39
6	Length of petiole (cm)	173.93	115.99	57.99	25.70	20.99	14.84
7	Width of petiole canal (cm)	1.26	1.19	0.07	41.95	40.76	9.89
8	Phylacron (days)	0.53	0.35	0.18	9.41	7.65	5.47
9	Length of pedicel (cm)	0.73	0.60	0.12	24.46	22.29	10.06
10	Duration of the crop (days)	301.41	262.81	38.60	4.67	4.36	1.67
11	Number of hands per bunch	7.78	7.14	0.64	32.54	31.18	9.35
12	Number of fingers per hand	10.76	8.61	2.15	21.64	19.36	9.68
13	Length of individual finger (cm)	104.94	8.62	96.32	66.98	19.20	64.18
14	Girth of individual finger (cm)	2.60	1.97	0.63	14.95	13.01	7.37
15	Weight of individual finger (g)	1652.35	1430.62	221.73	51.95	48.34	19.03
16	Total number of fingers per bunch	2765.63	2591.23	174.40	43.37	41.98	10.80
17	Bunch length (cm)	184.86	159.55	25.31	28.20	26.20	10.44
18	Bunch weight (kg)	23.76	20.71	3.06	48.38	45.17	17.35

Table 3. Correlations between bunch weight and their components, heritability, genetic advance and genetic gain of the different characters

Sl. No.	Characters	Phenotypic correlation	Genotypic correlation	Environmental correlation	Heritability	Expected genetic advance	Expected genetic gain
1	Height of pseudostem at shooting time	0.222**	0.253**	0.032	84.78	112.97	36.80
2	Girth at the base of pseudostem at shooting	0.579**	0.610**	0.418**	81.75	16.79	25.37
3	Number of leaves per plant at shooting time	0.366**	0.429**	0.145	71.33	3.85	24.18
4	Total number of leaves per plant	0.502**	0.587**	0.102	78.33	6.0	19.04
5	Leaf area	0.514**	0.614**	0.135	72.44	8.45	38.46
6	Length of petiole	0.096	0.037	-0.008	66.67	18.12	35.60
7	Width of petiole at	0.010	0.022	0.358**	91.44	2.19	79.93
8	Phylacron	-0.272**	-0.292**	-0.250**	66.15	1.0	12.90
9	Length of peduncle	0.275**	0.305**	0.105	83.09	1.46	41.05
10	Duration of the crop	0.229**	0.275**	-0.085	87.19	31.19	8.40
11	Number of hands per bunch	0.640**	0.649**	0.582**	91.75	5.27	53.96
12	Number of fingers per hand	0.427**	0.468**	0.222**	80.00	5.41	35.24
13	Length of individual finger	0.093	0.271**	0.059	8.22	1.73	11.83
14	Girth of individual finger	0.564**	0.597**	0.439**	75.72	1.52	23.35
15	Weight of individual finger	0.548**	0.522**	0.716**	86.58	72.50	53.17
16	Total number of fingers per bunch	0.582**	0.638**	0.507**	93.69	101.50	82.41
17	Bunch length	0.682**	0.713**	0.479**	86.31	24.17	49.78
18	Bunch weight				87.14	8.76	84.47

* Significant at 5 per cent level
** Significant at 1 per cent level

Table 4. Genotypic and phenotypic correlation coefficients among selected characters

Characters	Bunch weight (X1)	Number of hands per bunch (X2)	Girth of individual finger (X3)	Girth at the base of pseudostem at shooting time (X4)	Total number of leaves per plant (X5)	Leaf area (X6)	Bunch length (X7)	Total number of fingers (X8)	Weight of individual finger (X9)
(X1)		0.664" (0.660)**	0.596** (0.566)**	0.565** (0.557)**	0.525** (0.460)**	0.529** (0.517)**	0.727** (0.709)**	0.592" (0.596)**	0.534" (0.548)**
(X2)			-0.021 (0.027)	0.565** (0.541)**	0.461** (0.399)	0.682** (0.590)**	0.818" (0.780)**	0.939" (0.919)**	-0.171 (-0.120)
(X3)				0.281 (0.315)**	0.351* (0.303)**	0.209 (0.188)*	0.145 (0.145)	-0.092 (-0.044)	0.888" (0.834)**
(X4)					0.741" (0.644)**	0.887** (0.683)**	0.673** (0.616)**	0.548" (0.531)**	0.090 (0.139)
(X5)						0.735** (0.599)**	0.547" (0.487)**	0.381" (0.347)**	0.264 (0.242)**
(X6)							0.681** (0.600)**	0.631" (0.552)	0.053 (0.081)
(X7)								0.769" (0.739)**	0.120 (0.053)
(X8)									-0.282* (-0.234)**

Figures in brackets indicate phenotypic correlation coefficients

* Significant at 5 per cent level ** Significant at 1 per cent level

Table 5. Direct and indirect genotypic effects of eight component characters on yield

Characters	rg	Number of hands per bunch	Girth of individual finger	Girth at the base of pseud-stem at shooting time	Total number of leaves per plant	Leaf area	Bunch length	Total number of fingers per bunch	Weight of individual finger
Number of hands per bunch	0.664	0.2332	0.0006	0.0558	-0.0387	-0.0313	0.1886	0.3802	-0.1246
Girth of individual finger	0.596	-0.0048	-0.0289	0.0277	-0.0295	-0.0096	0.0335	-0.0372	0.6452
Girth at the base of pseudostem at shooting time	0.564	0.1318	-0.0081	0.0987	-0.0622	-0.0385	0.1551	0.2219	0.0656
Total mumber of leaves per plant	0.525	0.1076	-0.0102	0.0731	-0.0840	-0.0338	0.1260	0.1540	0.1920
Leaf area	0.579	0.1591	-0.0061	0.0826	-0.0617	-0.0459	0.1569	0.2557	0.0382
Bunch length	0.727	0.1908	-0.0042	0.0664	-0.0459	-0.0312	0.2305	0.3116	0.0086
Total number of fingers per bunch	0.592	0.2189	0.0027	0.0541	-0.0320	-0.0290	0.1770	0.4051	-0.2050
Weight of individual finger	0.534	-0.0399	-0.0257	0.0089	-0.0221	-0.0024	0,0028	-0.1143	0.7258

rg = Genotypic correlation coefficients between bunch wieight and its components
Figures underlined represent direct effect
Residual effect = 0.29

phenotypic as well as genotypic coefficient of variation (over 40%) thereby suggesting that there is high degree of variability in the varieties for these characters. Since major part of the variability is genetic, the same can be utilised for crop improvement programmes through selection. Sree Rangaswamy *et al.* (1980) also obtained similar results in culinary and dessert type bananas.

There is a significant positive correlation between bunch weight and 13 characters out of 17 characters studied (Table 3) both at phenotypic and genotypic levels. Between the phenotypic and genotypic correlations, the magnitude of the latter is seen to be slightly higher in majority of the cases, thereby indicating the preponderance of genetic relationship. Highest positive correlation with bunch weight was shown by bunch length followed by the number of hands per bunch. Other characters which showed high significant positive correlation with bunch weight are girth of individual finger, total number of fingers per bunch, leaf area, girth at the base of pseudostem at shooting time, weight of individual finger and total number of leaves per plant. The estimates of inter-correlations for these selected yield components have revealed that the number of hands per bunch, total number of fingers per bunch, bunch length, leaf area, girth at the base of pseudostem at shooting time and total number of leaves per plant are strongly and positively associated with each other (Table 4). Total number of fingers per bunch is seen to have significant negative association with weight of individual finger suggesting that improvement through selection of number of fingers per bunch is possible only at the expense of weight of individual finger.

Along with correlations, heritability, genetic advance and genetic gain are also useful parameters in deciding the favourable response of selection in a population. According to Johnson *et al.* (1955), heritability estimate alone will not give an indication of the amount of genetic progress that would result from selecting the best individuals. On the other hand, a consideration of heritability estimate and genetic advance jointly would enable one to arrive at a more reliable conclusion. According to Panse (1957), high heritability coupled with high genetic gain indicated additive gene effects while high heritability with low genetic gain indicated non-additive gene effects which included dominance and epistasis. Results (Table 3) indicate that components like number of hands per bunch, weight of individual finger, total number of fingers per bunch, bunch length and bunch weight have exhibited high heritability (over 86%) coupled with high or moderately high (over 50%) genetic gain estimates, thereby indicating the involvement of additive gene effects and consequently such characters can be improved through straight selection. Components like girth at the base of pseudostem at shooting time, total number of leaves per plant, girth of individual finger etc., are found to possess high heritability estimates (over 71%) coupled with low generic gain values (less than 25%) and hence such components are governed by non-additive genes through dominance or epistasis. As such, selection has very limited scope for improving these traits.

The association analysis through correlation and heritability estimates and values of genetic advance and genetic gain are incapable of providing a true picture of the relative merits or demerits of the role of each component to final yield, since an individual component may either have a direct influence in the improvement of yield or indirect role through other components in the improvement of yield, or both.

Results of path coefficient analysis (Table 5) have revealed that weight of individual finger has the maximum direct effect (0.7268) towards bunch weight followed by total number of fingers per bunch (0.4051), number of hands per bunch (0.2332), bunch length (0.2305) and girth at the base of pseudostem at shooting time (0.0987). The indirect effects of the three components, having negative direct effects, through these traits are also seen to be positive and fairly high, suggesting that these five are the important characters contributing to yield in banana. Direct effects on bunch weight of components such as girth of individual finger (-0.9289), total number of leaves per plant (- 0.0840) and leaf area (-0.9456) are negative although they have contributed high significant genotypic correlation coefficients with bunch weight. But the positive indirect effects of these traits through other characters are very high thereby explaining the high genotypic correlation with bunch weight. Girth of individaul finger is having positive indirect effect on bunch weight through weight of individual finger (0.6452), bunch length (0.0335) and girth at the base of pseudostem at shooting time (0.0277). Similarly total number of leaves per plant is having positive indirect effect on bunch weight through weight of individual finger (0.1920), total number of fingers per bunch (0.1540), bunch length (0.1260), number of hands per bunch (0.1076) and girth at the base of pseudostem at shooting time (0.0731). The positive indirect effect of leaf area on bunch weight is through number of fingers per bunch (0.2557), number of hands per bunch (0.1591), girth at the base of pseudostem at shooting time (0.0826) and weight of individual finger (0.0382). The residual effect worked out in the path analysis is only 0.082. This indicates that about 92 per cent of yield in banana is contributed by eight component traits considered for path analysis. Hence improvement in weight of individual finger, total numbers of fingers per bunch, number of hands per bunch, bunch length and girth at the base of pseudostem at shooting time will result in increased bunch weight in banana.

Selection indices formulated using different combinations of characters, revealed that selection through discriminant function by considering the characters viz., number of hands per bunch, bunch length, total number of fingers per bunch and weight of individual finger together with bunch weight was the most effective one.

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