Madras Agric. J., 95 (7-12) : 258-265 July-December 2008
https://doi.org/10.29321/MAJ.10.100580

Genetic variability and correlation studies in banana (*Musa* spp.)

C.RAJAMANICKAM AND K.RAJMOHAN
Dept. of Pomology and Floriculture, College of Agriculture, Vellayani – 695 522, Thiruvananthapuram, Kerala.

Abstract : Twenty eight clones and intraclones of banana (*Musa* spp.) were studied for their genetic variability and correlation among various fruit characters. The genetic and phenotypic variances and coefficients of variance, heritability, genetic advance and coefficients of correlation were estimated for seventeen characters which included plant height, suckers per plant, leaves per plant, leaf width, days from planting to shooting, sugar/acid ratio, girth, length, weight and volume of finger, hand weight, ripe fruit weight, bunch weight, bunch length, fingers per bunch, fingers per hand and pulp weight. A remarkable variability was observed among the collections for these characters. All the characters showed higher estimates of broad sense heritability whereas genetic advance was recorded very high in volume of finger followed by weight of finger, ripe fruit weight, pulp weight and fingers per bunch. The values of high PV, GV, PCV, GCV heritability and genetic advance make them the prime characters for the direct selection. The weight of finger, bunch weight, volume of finger and fingers per bunch showed the high genetic advance and high heritability were the other important characters which had to be considered for selection of the clones.

Key words : Banana, Heritability , Genetic advance, Genetic and Phenotypic coefficient of variance, Correlation.

Introduction

The primary object of a crop improvement programme is a critical assessment of genetic variability existing in that particular crop and the extent to which the character to be improved is heritable. Burton (1952) has pointed out that calculating the genetic coefficient of variation along with heritability can assess a best picture of the amount of advancement to be expected by selection. Ramanujam and Thirumalachar (1967) have suggested that the heritability estimate in the broad sense will be reliable, if accompanied by a high genetic advance. Johnson *et al.* (1955) and Swarup and Changle (1967) also consider that heritability estimates along with genetic gain are useful and reliable than heritability estimates alone in predicting the selection response. 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. In the present investigation, a critical assessment made on the biometrical studies on seventeen characters of twenty eight banana clones and intraclones were studied.

Table 1. Cultivars, banana types, ploidy and genomic composition of banana clones

S.No.	Clone Name	Type	Ploidy	Genomic Composition
1.	Red banana	Dessert	3x	AAA
2	Vellakappa	Dessert	3x	AAA
3	Robusta	Dessert	3x	AAA
4	Vellayani Nendran	Dessert	3x	AAB
5	Padalamurian	Dessert / cooking	3x	AAB
6	Myndoli	Dessert / cooking	3x	AAB
7	Chengazhikodan	Dessert / cooking	3x	AAB
8	Attu Nendran	Dessert / cooking	3x	AAB
9	Kaliethan	Dessert / cooking	3x	AAB
10	Koonoor Ethan	Dessert / cooking	3x	AAB
11	Mysore Ethan	Dessert / cooking	3x	AAB
12	Zanzibar	Dessert / cooking	3x	AAB
13	Quintal banana	Dessert / cooking	3x	AAB
14	Changanasseri Nendran	Dessert / cooking	3x	AAB
15	Manjeri Nendran	Dessert / cooking	3x	AAB
16	Palode Palayankodan	Dessert	3x	AAB
17	PKNNR	Dessert	3x	AAB
18	Chandra Bale	Dessert	3x	AAB
19	Pisang Ceylon	Dessert	3x	AAB
20	Mottapoovan	Dessert	3x	AAB
21	Vellapalayankodan	Dessert	3x	AAB
22	Monthan	Cooking	3x	ABB
23	Peyan	Cooking	3x	ABB
24	Kadali	Dessert	2x	AA
25	Pisang Lilin	Dessert	2x	AA
26	Njalipoovan	Dessert	2x	AB
27	Kunnan	Dessert	2x	AB
28	Ilavazha	Leaf purpose	2x	BB

Materials and Methods

Twenty eight clones and intraclones of banana were planted in a completely randomized block design suggested by Panse and Sukhatme (1967). The twenty eight banana clones and intraclones selected for this study are presented in Table 1. Suckers of the clones and intraclones of banana, almost uniform size were collected from different parts of Kerala and Tamil Nadu and were planted and maintained in the Instructional Farm, College of Agriculture, Vellayani. Suckers of Kaliethan, Koonoor Ethan, Quintal banana, Vellayani Nendran, Monthan, Red banana, Vellakappa and Robusta

Table 2. Variability parameters for different characters in 28 banana clones

Characters	Mean + SE	Range	PV	GV	PCV	GCV	Heritability	Genetic advance	Genetic advance as % of mean
Plant height (cm)	314.71 + 4.31	426-201	51.84	51.55	16.48	16.39	98.94	105.72	33.59
Suckers per plant	10.49+0.39	28-4.00	4.65	4.40	44.53	42.11	89.43	8.60	82.06
Leaves per plant	8.61+0.19	12-5.00	1.41	1.20	16.38	13.94	72.39	2.10	24.39
Leaf width (cm)	73.35+0.69	95.9-56.70	8.33	7.82	11.36	10.65	87.93	15.09	20.57
Fruits per hand	13.44+0.29	20.0-6.6	3.52	3.35	26.18	24.94	90.74	6.57	48.92
Fruits per bunch	109.44+5.36	268.0-17.0	64.59	63.92	59.02	58.41	97.95	130.33	119.09
Bunch weight (kg)	15.61+0.53	37.0-5.5	6.55	6.27	40.88	39.12	91.57	12.03	77.11
Hand weight (kg)	2.29+0.07	5.0-0.90	0.79	0.74	37.50	34.84	86.31	1.52	66.37
Bunch length (cm)	72.11+1.65	150.2-33.5	19.87	19.08	27.55	26.45	92.18	37.73	52.32
Finger weight (g)	186.56+7.95	535.875.5	80.92	80.76	51.36	51.27	99.62	196.67	105.42
Length of finger (cm)	18.48+0.57	38.6-7.5	6.15	6.06	36.79	36.29	97.28	13.63	73.75
Girth of finger (cm)	12.46+0.24	18.6-6.1	2.76	2.63	23.54	22.35	90.11	5.44	43.69
Volume of finger (cc)	177.23+8.02	532.5-64.5	80.51	80.24	54.55	54.38	99.35	197.89	11.65
Ripe fruit weight (g)	162.85+7.08	435.1-63.6	72.00	71.88	52.38	52.28	99.63	175.08	107.50
Pulp weight (g)	135.63+6.19	375.0+49.50	62.85	62.70	54.95	54.83	99.55	152.86	112.70
Days from planting to shooting	231.76+2.70	305.0-170.0	32.45	31.80	14.01	13.71	95.93	64.15	27.67
Sugar / acid ratio	54.25+1.13	86.69-29.35	12.72	12.17	24.95	23.89	91.67	25.56	47.11

were collected from the Instructional Farm, College of Agriculture, Vellayani. The suckers of Kadali, Kunnan, Vallapalayankodan, Peyan, Pisang Lilin, Njalipoovan and Palode Palayankodan varieties were collected from Banana Farm, Peringamala, Palode, Thiruvananthapuram Mottapoovan, Chandra Bale, Pisang Ceylon, PKNNR, Padalamurian, Mysore Ethan, Myndoli, attu Nendran, Chengazhikodan, Changanasseri Nendran, Manjeri Nendran and Zanzibar were collected from Banana Research Station (BRS), Kannara. The suckers of Havazha were collected from Batlagundu, Tamil nadu. The observations were recorded on height and girth of the plant, leaves per plant, leaf width, fruits per hand and bunch, bunch weight, hand weight, bunch length, finger characters like, length, girth, weight and volume of the finger, ripe fruit weight, pulp weight, days from planting to shooting and sugar / acid ratio were also recorded. Biometrical data were collected and statistically analysed following Fischer (1960). From the analysis of variance, the genetic parameters like phenotypic and genotypic coefficients of variation (PCV and GCV), phenotypic and genotypic variances (PV and GV) were calculated (Burton, 1952). Habitability estimates (Burton and de Vane, 1953) and genetic advance (Allard, 1960) and correlation by the method of Al-Jibouri *et al.* (1958). The work was carried out at the Department of Pomology and Floriculture, College of Agriculture, Vellayani during the year 2001-

banana clones and intraclones, of almost uniform size were collected from different parts of Kerala and Tamil Nadu. Spacing adopted was 2.0 x 2.0 m. The cultural practices as per the Package of Practices recommendations (KAU, 1996) were followed.

Results and Discussion

The phenotypic and genotypic co-efficients of variation for the seventeen morphological characters of twenty eight banana clones were studied. The PCV were higher than their respective GCV for all the characters which reflected the influence of environment on the phenotypic expression of these characters. A significant difference was recorded among the various clones and intraclones of banana for different plant parameters studied. The experimental results presented in Table 2 indicate the range and general mean for each character under the study with wide variations in mean values. The highest range of variation was shown by fruits per bunch, bunch length, finger weight, volume of finger, ripe fruit weight, plant height, and pulp weight. The lowest range of variation was recorded by suckers per plant, leaves per plant, leaf width, fruits per hand, bunch weight, finger length and girth of finger.

The phenotypic and genotypic variances, PCV, GCV, heritability and genetic advance are presented in Table 3. Generally, the phenotypic component of variance was found higher than the genotypic component and the extent of latter component also showed that they were mostly heritable in nature. Estimates of different genetic parameters clearly showed that the values of phenotypic variance were higher than genotypic variance. This clearly suggests that the environment influences the expression of all the characters. This is in line with the reports on dessert types of banana by Nayar *et al.* (1979). The phenotypic variance ranged from 0.79 per cent (hand weight) to 80.92 per cent (finger weight). The highest PV was recorded in finger weight (80.92%), followed by volume of finger (80.51%), ripe fruit weight (72.00%) and pulp weight (62.85%). The lowest PV was observed in hand weight (0.79%) followed by leaves per plant (1.40%), girth of finger (2.76%) and fingers per hand (3.562%). The genotypic variance ranged from 0.74 per cent (hand weight) to 80.76 per cent (finger weight). The highest GV was recorded in finger weight (80.76%) followed by volume of finger (80.24%), ripe fruit weight (71.88%) and pulp weight (62.70%). The lowest GV was exhibited in hand weight (0.74%) followed by leaves per plant (1.20%), girth of finger (2.63%) and fingers per hand (3.35%). The variation between phenotypic coefficient of variation and genotypic coefficient of variation is due to the fact that phenotypic variability includes genetic variability and effect of environment besides genotypic-environmental interaction. The highest PCV was observed from the characters like fingers per bunch (59.02%) followed by pulp weight (54.95%), volume of finger (54.55%), ripe fruit weight (52.38%) and finger weight (51.36%). The lowest PCV value was observed in leaf width (11.36%) followed by days from planting to shooting (14.01%). The GCV is a better tool to understand useful variability, as it is free from the environmental components. The GCV helps in comparison and measurement of genetic variability among different characters. The GCV ranged from 10.65 per cent for leaf width to 58.41 per cent for fingers per bunch. The highest GCV was recorded from the characters like fingers per bunch followed by pulp weight, volume of finger, ripe fruit weight and finger weight. Work of Rajeevan and Geetha (1982) is also a support for this study with high estimates of GCV. The lowest

Table 3. Genotypic (G) and Phenophytic (P) correlation coefficients among some characters of banana clones

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
X1	1.0000																
X2	0.3194	1.0000															
X3	0.4625*	0.2339	1.0000														
X4	0.3542	0.0378	0.4103*	0.6558**													
X5	0.1043	0.0479	-0.2984	0.2637	1.0000												
X6	0.1656	0.0372	-0.2654	0.1867	0.9297**	1.0000											
X7	0.6038**	0.2029	0.0599	0.4112*	0.3869*	0.4350*	1.0000										
X8	0.2327	0.4288*	0.4771*	0.3642	-0.2371	-0.3143	0.3292	1.0000									
X9	0.5483**	0.0331	-0.0393	0.4722*	0.6632**	0.7146**	0.6990**	-0.0785	1.0000								
X10	0.1048	0.3765*	0.4162*	0.0235	-0.6391**	0.7093**	0.0752	0.7641**	-0.3934*	1.0000							
X11	0.0756	0.3179	0.3996*	-0.0500	-0.6636**	0.7626**	0.1128	0.6744**	-0.4114*	0.9250**	1.0000						
X12	0.2929	0.3485	0.3782*	0.2297	0.5221**	0.5825**	0.2557	0.7782**	-0.0221	0.8076**	0.7502**	1.0000					
X13	0.1044	0.3859*	0.4124*	0.0049	0.1466**	0.7094**	-0.0893	0.7629**	-0.4171*	0.9979***	0.9235**	0.7904**	1.0000				
X14	0.1058	0.3351	0.3917*	0.0398	-0.6446**	-0.7165**	-0.0526	0.7744**	0.3732	0.9940**	0.9225**	0.8225**	0.9917**	1.0000			
X15	0.0892	0.3289	0.4070*	0.0489	-0.6659**	-0.7318**	-0.0807	0.7592**	-0.3891*	0.9892**	0.9109**	0.8218**	0.9828**	0.9933**	1.0000		
X16	0.4399**	0.0817	0.1939	0.0915	-0.1511	-0.1478	0.1244	-0.0750	0.1284	0.0871	0.2514	0.1058	0.0958	0.0557	0.0374	1.0000	
X17	0.4206*	0.3152	0.5276**	0.2911	-0.4334*	-0.4474*	-0.0033	0.4414*	-0.1012	0.5416**	0.5404**	0.4529*	0.5494**	0.5317**	0.5402**	0.4272*	1.0000

* - Significant at 5 per cent ; ** - Significant at 1 per cent.

X1 - Plant height
X2 - Suckers per plant
X3 - Leaves per plant
X4 - Leaf weight
X5 - Fingrs per hand
X6 - Fingers per bunch
X7 - Bunch weight
X8 - Hand weight
X9 - Bunch length
X10 - Weight of finger
X11 - Length of finger
X12 - Girth of finger
X13 - Volume of finger
X14 - Ripe fruit weight
X15 - Pulp weight
X16 - Days from planting to shooting
X17 - Sugar / acid ratio

GCV value was observed in leaf width following by days form planting to shooting. Rajeevan and Geetha (1982) observed high PCV and GCV values for bunch weight, number of fingers, number of hands, length of finger and weight of finger of 40 banana cultivars. The wide difference in PCV and GCV and very low estimates of GCV indicate the immense influence of environment of the manifestation of this character. The similar findings were also made by Sreerangaswamy *et al.* (1980) in banana. A very high difference between phenotypic and genotypic coefficient of variation met with the plant height, leaf width, fruits per bunch, bunch weight, bunch length, finger weight, finger length, volume of finger, ripe fruit weight and pulp weight suggested that in these characters the environmental influence was not marked. The estimates of heritability separate the genetic variability from phenotypic variability and indicate the possibility and extent to whic improvement can be brought about through proper selection. Heritability in broad sense gives the amount of heritable portion of a character. Characters possessing high heritability can be improved directly through selection as they are less affected by the environment. The magnitude of heritability indicates the effectiveness of selection based on phenotypic performance (Johnson *et al.* 1955). All the characters exhibited high heritability which ranged from 72.39 per cent for leaves per plant to 99.94 per cent (plant height). The characters like plant height (98.94%), suckers per plant (89.43%), leaves per plant (72.39%), leaf width (87.93%), fingers per hand (90.74%), fingers per bunch (97.95%), bunch weight (91.57%), weight of hand (86.31%), length of bunch (92.18%), weight of finger (99.62%), length of finger (97.28%), girth of finger (90.11%), volume of finger (99.35%), ripe fruit weight (99.63%), pulp weight (99.55%), days from planting to shooting (95.93%) and sugar / acid ratio (91.67%) had high heritability. Their relatively higher values of heritability imply that large proportion of phenotypic variance was attributable to the genotypic variance. The high heritability for fingers per bunch, weight of finger and ripe fruit weight obtained in the present studies are in agreement with the findings of Sreerangaswamy *et al.* (1980) in banana. The high heritability was also reported for leaves at flowering and number of hands (Rajeevan and Geetha, 1982), leaf area per plant and finger volume (Valsalakumari and Nair, 1986), bunch length (Rosamma and Namboodiri, 1990) and bunch weight (Uma *et al.*, 2000). Heritability has been clearly demonstrated by various workers including Katiyur *et al.* (1974) that the heritability values alone cannot be taken as a tool to calculate the amount of genetic progress that would result from selecting the best individual. Ramanujam and Thirumala-char (1967) reported that the heritability estimates in the broad sense would be reliable if accompanied by a high genetic advance.

In the present investigation, there was a wide variation among the characters for their genetic advances. Genetic advance varied from 1.52 per cent for weight of hand to 197.89 per cent for volume of finger. The characters like volume of finger followed by weight of finger, ripe fruit weight, pulp weight and fingers per bunch showed higher genetic advance along with a high heritability. This clearly suggests that these characters are mainly of additive types as reported by Johnson *et al.* (1955). The lowest genetic advance obtained for weight of hand followed by leaves per plant and girth of finger. Fingers per bunch with the high value of PCV, GCV and heritability coupled with genetic advance indicated that the character was predominantly controlled by additive gene action. This is

supported by the hypothesis proposed by Panse and Sukhatme (1967) suggesting that characters exhibiting high heritability and GA were governed by additive gene effects. High heritability does not necessarily mean a high genetic advance for a particular character (Allard, 1960). Heritability along with genetic advance is more useful than heritability alone in predicting the result and effect of selecting the best individuals (Johnson *et al.* 1955). Uma *et al.* (2000) reported that plant height with very high value of heritability and moderate value of genetic advance, revealing relatively low influence of environment on this trait. Correlation provides information on the nature and extent of association between characters in a population. The component characters always show inter relationships. When selection pressure is applied on a trait, the population under selection is improved not only for that trait but also for other characters associated with it. This facilitates simultaneous improvement of two or more characters. Therefore, analysis of yield in terms of phenotypic and genotypic correlation coefficients of component characters helps in understanding characters that can form the basis of selection. The phenotypic and genotypic correlations are presented in Table 3. In correlation studies, the bunch weight had significant phenotypic correlation with plant height, psuedostem girth, leaf length, leaf width, fingers per bunch and bunch length. Significant genotypic correlation with bunch weight was seen for plant height, pseudostem girth, leaf length, leaf width, fingers per hand, fingers per bunch and length of bunch. The highly significant phenotypic correlation of bunch weight with number of fruits per bunch obtained in the present study is an agreement with the findings of Rosamma and Namboodiri (1990). Significant association of bunch weight of banana with fingers per hand at genotypic level was reported by Krishnan and Shanmugavelu (1983) and Rosamma and Namboodiri (1990). Positive significant phenotypic and genotypic correlations of plant height with bunch weight as seen in the present studies was earlier reported by Krishnan and Shanmughavelu (1983). Significant positive association of pseudostem girth with bunch weight at phenotypic and genotypic level is in agreement with the earlier reporters by Krishnan and Shanmugavelu (1983) and Rosamma and Namboodiri (1990). The positive phenotypic and genotypic association with number of fruits per bunch and bunch length obtained in the present study is in conformity wit the findings of Sunilkumar (1997) in banana. Significant phenotypic and genotypic correlation of girth of finger with length of finger seen in the present study was also reported earlier by Sunilkumar (1997) in banana. Weight of finger showed the positive correlation with girth of finger and length of finger supported by the findings of Sunilkumar (1997) in banana.

References

Al-Jibouri, H.A., Miller, P.A. and Robinson, H.F. (1958). Genotypic and environmental variances and covariance in upland cotton cross of inter specific origin. *Agron. J.*, **50:** 633-636.

Allard, R.W. (1960). Principles of Plant Breeding. John Wiley & Sons Inc., New York, P. 460.

Burton, C.W. (1952). Quantitative inheritance in grasses. *Proc. 6th Int. Grassland Congr.*, **1 :** 277-283.

Burton, G.W. and deVane, E.H. (1953). Estimating heritability in tall fescue *(Festuca arundinacea)* from replicated clonal material. *Agron. J.*, **45 :** 478-481.

Fischer, R.A. (1960). The design of experiments. Hafner Publishing Co., Inc., New York, p.50-67.

Johnson, H.W., Robinson, H.F. and Comstock, R.E. (1955). Estimates of genetic and environmental variability in soyabeans. *Agron. J.,* **47 :** 314-318.

Katiyar, R.P., Mishra, B., Singh, S.N., and Chauhan, Y.S. (1974). Genetic variability, heritability and genetic advance of yield and its components in Indian mustard. *Indian J. Agrl. Sci.,* **44(5) :** 291-293.

KAU. (1996). Package of Practices Recommendation. Kerala Agricultural University, Vellanikkara, Thrissur.

Krishnan, B.M. and Shanmugavelu, K.G. (1983). Correlation studies in banana cv. Robusta, *South Indian Hort.,* **31(2) :** 110-111.

Nayar, N.K., Lyla, K.R. and Mathew, V. (1979). Estimation of genetic variability in banana (*Musa* spp.) for quantitative traits : 1. The desert types. *Indian J. Agrl. Sci,* **9 :** 414-416.

Panse, V.G., and Sukhame, P.V. (1967). Statistical methods for agricultural workers. 2nd edition, ICAR, New Delhi.

Rajeevan, P.K. and Geetha, C.K. (1982). Variability studies in banana. *South Indian Hort.,* **34 :** 197-200.

Ramanujam, S. and Thirumalachar, D.K. (1967). Genetic variability of certain characters in red pepper (*Capsicum annuum* L.) *Mysore J. Agric.,* **1 :** 30-36.

Rosamma, C.A. and Namboodiri, K.M.N. (1990). Genetic analysis of yield in banana, *Agric. Res. J. Kerala,* **28 :** 1-8.

Sreerangaswamy, S.R., Samandamurthy, S. and Murugan, M. (1980). Genetic analysis in banana. National seminar on banana production technology. TNAU, Coimbatore. (eds. C.R. Muthukrishnana and J.B.M. Abdulkhader). p. 67-70.

Sunilkumar, K. (1997). Selection of superior types of Kaleithan (*Musa* AAB group) Nendran. M.Sc., (Hort) thesis, Kerala Agricultural University, Thrissur.

Swarup, V. and Chaugle, D.S. (1967). Studies on genetic variability in sorghum. 1. Phenotypic variations and its heritable components in some quantitative characters contributing towards yield. *Indian J. Genetic.,* **22 :** 31-36.

Uma, S., Dayarani, M., Singh, H.P., Shyam, B. and Sathiamoorthy, S. (2000). Studies on genetic variability in banana silk subgroup (AAB). *Indian J. Hort.,* **57(2) :** 106-109.

Valsalakumari, P.K.and Nair, P.C.S. (1986). Genetic variability in banana. *Agric. Res. J. Kerala,* **24(1) :** 66-72.