BIOMETRICAL STUDIES IN BANANA

By

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THESIS

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DECLARATION

I hereby declare that this thesis entitled "BIOMETRICAL STUDIES IN BANANA" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

Vellanikkara,
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CERTIFICATE

Certified that this thesis is a record of research work done independently by Miss. Rosamma, C.A. under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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CERTIFICATE

We, the undersigned, members of advisory committee of Miss. Rosamma, C.A., a candidate for the degree of Master of Science in Agriculture with major in Plant Breeding, agree that the thesis entitled "BIOMETRICAL STUDIES IN BANANA" may be submitted by Miss. Rosamma, C.A. in partial fulfilment of the requirements for the degree.

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Introduction

INTRODUCTION

Banana is one of the most important fruit crops of the world, with an estimated annual production of 20 million tons. It is grown over a wide range of conditions. Africa contributes about 50 percentage of the total acreage of banana in the world, the rest being shared equally by Asia and America.

Among the various Asian countries growing banana, India is an important one accounting for 2,36,200 ha under banana, which is 15 per cent of the total area of fruits in the country. However, banana production in India is not comparable to that of various other countries. Though India ranks second in acreage, its contribution to world market is rather negligible.

Among the various States of India, Kerala ranks first in acreage (49,558 ha) and total production (3,09,914 tons) (Anon, 1982). The other important States of the country growing banana are Tamil Nadu, Maharashtra, Andhrapradesh, Karnataka, Orissa, Bihar and West Bengal. Of the total area under banana in the country 54 per cent is confined to the southern States of Kerala, Tamil Nadu and Maharashtra.

There have been evidences to show that banana has been a staple food for thousands of people for many years in the past. Now it is recognised as an important commercial fruit of the tropical belt. Like potato, banana yields highest amount of energy giving food per unit area. The ripe fruit is a good source of vitamins and minerals and it contains upto 27 per cent of sugars.

For commercial cultivation, India does not depend on a single variety of banana as in the case of West Indies or Central America and hence the method of improvement adopted here also is very much different. The morphological variations in cultivated bananas which consist of both diploids and triploids are high and complex with combinations of different degrees of expression of characteristics of the parental species, Musa acuminata and Musa balbisiana. Moreover the occurrence of somatic mutations in banana offers greater and easier scope for selection of desirable type of varieties for commercial cultivation. Being a vegetatively propogated crop, the selected superior genotypes can be maintained through clonal propagation.

As the demand for this fruit in the international trade is growing very fast and as it fetches a

higher foreign exchange among the fruits of the tropics, any attempt to increase its productivity is most desirable and attractive.

Biometrical studies on variability, heritability, genetic advance and extent of association of yield components with final yield enable the breeders to programme their approach in manipulating the expression of characters channelising towards higher yield.

Selection is the basis for all crop improvement programmes and an estimate of the extent of variability available in a breeding population will be of immense value to design a selection procedure and to identify superior genotypes. In such an evaluation, analysis of the genetic situation in a character is utmost important (Panse, 1957). In selection for yield, such attributes that show less variability due to environment need a greater stress. The variability can be partitioned into heritable and nonheritable components with the aid of genetic parameters as genotypic coefficient of variation, heritability and genetic advance, which serve as a basis for selection.

Selection pressure can more easily be exerted on any character which show close association with yield. Associations of plant characters determined by correlation coefficients have always been helpful in selecting desirable traits. As such it is necessary to rely more on such morphological characters as indices of yield than the yield itself in the process of selection.

Selection indices provide a basis for simultaneous improvement of more than one character by selection, or enhancing the effectiveness of selection for one character by incorporating information on one or more secondary characters. Identification of component characters and finding out the weight to be attached with the characters would help to maximise genetic gain through selection. No work seems to have been done in banana to estimate the efficiency of straight selection for complex characters over selection through discriminant function or vice-versa.

Yield being a complex character is dependant on a number of components and the association of yield with its component characters is of immense value in selection of superior genotypes. Therefore it is necessary to know the direct and indirect effects of each of the components on yield especially when more number of

variables are included. Path coefficient analysis developed by Wright provides the relative importance of each of the causal factors and is now used in increasing manner in many crops including vegetatively propogated ones and it involves effective partitioning of the correlation coefficients into direct and indirect effects.

Biometrical studies have proved themselves to be of immense worth to the plant breeders because they help in the clear understanding of absolute criteria on the basis of which inherently and economically superior and desirable types and varieties could be evolved.

A review of literature indicated that only very little work has been attempted in banana along these directions. Hence evaluation of available germplasm in this regard is highly necessary and the present investigations were undertaken with the following objectives.

1. To estimate the genotypic and phenotypic correlation coefficients for selected characters between themselves and with yield.

2. To separate the correlation coefficients into direct and indirect effects through the path coefficient

analysis in order to get some idea of the causal system of the factors contributing to yield.

3. To estimate heritability and genetic advance for the different characters.

4. To find out efficiency of selection through discriminant function over straight selection or vice versa.

Review of Literature

REVIEW OF LITERATURE

Banana is an important fruit crop extensively grown in the tropical countries. However, information on the relative contributions of yield components as well as their direct and indirect effects on fruit yield is limited. Studies in the past were mostly confined to correlation between various plant characters and only recently the variability, heritability and genetic advance were studied. A review pertaining to the aspects of the present study in banana is given below. Similar works on other important vegetatively propogated fruit crops are also included in the review wherever the literature in banana is seen to be insufficient. The important findings relevant to the present study are reviewed under the following heads.

1. Correlation studies
2. Variability
3. Heritability and genetic advance
4. Path coefficient analysis

1. Correlation studies

In a programme of breeding for improving the yield potential of a crop, information on the interrelationship of yield with other traits is of immense

help. This will facilitate selection of suitable high yielding plants through other related components. Measurements of phenotypic, genotypic and environmental correlations between yield and other characters have been reported by many workers in fruit crops and a review of this is presented below.

A. Association between yield and its components

Banana (*Musa* spp.)

According to Murray (1961) in Dwarf Cavendish banana the size (length x breadth) of third leaf at the age of six months and final weight of bunch were highly correlated.

Hasselo (1962) obtained a close correlation between bunch weight and circumference of pseudostem at the time of emergence of inflorescence. Extensive statistical studies carried out by Lossois (1963) on banana plantations of different ages showed a high correlation between yield and circumference of pseudostem 1 m above soil surface at flowering time. Simple, partial and multiple correlation studies conducted by Teaotia *et al.* (1970) led to the conclusion that bunch yield was strongly correlated with

pseudostem circumference. He also pointed out that simple regression of yield on pseudostem circumference could be expected to be as informative as multiple regression because the influence of other characters like leaf number and height was negligible and their inclusion did not add much information.

Turner (1970a) reported that leaf length duration (leaf length x longevity) was positively related to bunch weight.

Lassoudiere et al. (1974) established a relationship between bunch weight and grade (measure of finger thickness) of the second hand.

Studies of Warner et al. (1974) showed a direct relation between yield, height of pseudostem and girth.

According to Turner (1980) the area of leaves emerging at the midfloral stage of plant growth was positively correlated with the total number of fruits per bunch. The leaf area duration of last three leaves was related to mean fruit weight.

The genotypic correlation studies conducted by Sree Rangaswamy et al. (1980) showed a negative association of bunch weight with height in dessert type

bananas and positive association of bunch weight with stem girth, bunch length and number of fruits and hands per bunch in culinary types.

A study conducted by Nambisan and Rao (1980) on the influence of specific origin on leaf production and associated growth characters showed that the ratio of leaf area to fruit weight was least influenced by the specific origin. The ratio of leaf area duration to fruit weight was generally highest in Musa balbisiana derivatives.

From the intra group correlation studies involving three genomic groups of banana conducted by Gopimony and Marykutty (1980) it was found that only the fingers per bunch was positively correlated with bunch weight in all the three genomic groups. But in AAA and AAB groups, the girth of pseudostem gave clear indication of bunch weight.

Pineapple (Ananas comosus)

For the variety Baronne de Rothschild, a close correlation was obtained between the weight of 'D' leaf (youngest adult leaf) at the time when acetylene or flowering - hormone treatment was given and the

weight of the fruit harvested 5½ to 6 months later. This relation was true for harvest obtained at different periods (Py and Polegrin, 1958). Py and Lossois (1962) also obtained a correlation between weight of the fruit and weight of the 'D' leaf but not nearly so high as that found in Baronne de Rothschild, the lower coefficient being attributed to greater drought sensitivity and lower rainfall. A very satisfactory correlation was found when the weight of 'D' leaf at the time of treatment was replaced by an estimated weight of the plant's total foliar mass. The degree of correlation with fruit weight was reduced when the weight of original sucker was included in the sum.

Chadha et al. (1977) reported that increase in leaf number one year after planting resulted in increased fruit weight. Studies of Prabhakaran and Balakrishnan (1978) showed a positive correlation between number of leaves and yield. Dimensions of the 'D' leaf did not show any significant association with yield in the case of plants having fixed number of leaves. They also showed a negative correlation between fruit weight and crown weight.

Grapes (*Vitis* spp.)

Angelo (1927) and Anteliff *et al.* (1958) reported that productiveness of the cane increased with increase in diameter. According to Karuppu Swami *et al.* (1960) Anab-e-Shahi Canes with diameter of 8 - 10 mm were more productive than those in other ranges.

Winkler (1930) reported that increase in the amount of crop was the direct result of increase in leaf area. Veg and Fox (1950) showed statistically the existence of (1) a highly significant direct correlation between the average area of 6th leaf from the base on the primary fruiting shoots and fruit yield and (2) a significant direct correlation between areas of 6th, 7th and 8th leaves taken together and yield. In an experiment conducted by Reddy (1978) the berry weight and volume were significantly correlated with leaf area, but the mean size and number of berries per bunch had no association.

Strawberry (*Fragaria* spp.)

Bedard *et al.* (1971) found that total berry weight was positively and significantly correlated with

average berry weight, berries per flower stalk, yield per flower stalk, leaf area and petiole diameter, but negatively correlated with stolon number and flower stalk number. There was inverse relation between flower stalk number and average berry weight.

Lacey (1973) grouped the vegetative characters associated with yield into two categories. Those associated with fruit number (number of leaves during preceeding autumn and winter) and those associated with fruit size (plant size during the preceeding seasons).

Cranberry (Vaccinium macrocarpon)

Eaton and Mc Pherson (1977) identified the components on yield in cranberry. The number of flowering uprights per unit area made a major contribution to yield. The number of flowers per upright and berry set made less important contributions. The effect of berry size was negligible.

B. Inter correlation among yield components

Summerville (1944) reported positive correlation between height, girth and number of last leaf unfurled.

Alexandrowicz (1955) correlated height of pseudostem with leaf area. According to Ahmad *et al.* (1974) the pseudostem base girth was related to plant height.

Intra group correlation studies conducted by Gopimony and Marykutty (1980) showed that height was significantly correlated with girth, leaf area, number of fingers and number of hands in all the three genomic groups; whereas its correlation with number of leaves at bunching and bunch weight was significant only in the case of AAB genome. Regarding the correlation of girth with other characters, it was found that the girth was positively and significantly correlated with height, leaf area, number of leaves at bunching and number of fingers in all the three genomic groups; whereas it was significantly correlated with number of hands in AAB group and bunch weight in AAA and AAB groups only. Number of hands was highly correlated with number of fingers in all three genomic groups under study. Leaf area of the third leaf at the sixth month of planting was significantly and positively correlated with all other characters except bunch weight. Number of leaves at bunching was significantly correlated only with girth and leaf area in all three

groups but in AAB group it was significantly correlated with height also. Number of fingers was positively and significantly correlated with all other characters except the number of leaves at bunching.

The area of leaves emerging at the mid floral stage of plant growth was positively correlated with total number of fruits per bunch (Turner, 1980).

In strawberry, Bedard et al. (1971) showed an inverse relation between flower stalk number and berries per flower stalk.

In sweet cherry there was high positive genetic correlation among the traits full bloom date, ripe date, fruit firmness and fruit diameter (Hensche et al., 1966).

2. Variability

A successful programme of breeding for high yield and other desirable characters requires information on the nature and magnitude of variation in the available germplasm. Many workers have studied, the extent of variability in various fruit crops by working

out genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV). But the extent of genetic variability is more important than total variation since greater the genetic diversity, wider will be the scope for selection. A brief review on this aspect is made here.

Banana (*Musa* spp.)

Wide variation was noticed for all characters contributing to yield. Significantly wide variation among the varieties for all the morphological features was reported in dessert type banana by Nayar *et al.*(1978). The genotypic variance and genotypic coefficients of variations were high for weight of hands and length of fruits. Environmental variance was maximum for length of fruits followed by weight of hands. Studies of Nayar *et al.* (1980) on culinary bananas also showed a wide and significant variation among the varieties for all the characters. There was wide variation in mean value for weight of hands followed by roots per plant and number of fruits per bunch. Genotypic variance and genetic coefficient of variation were maximum for weight of fruits followed by weight of hands. Girth of

plant, number of leaves per plant, number of fruits per bunch and length of pedicel showed moderately higher values of genotypic variance. A minimum difference between phenotypic and genotypic coefficients of variation and phenotypic and genotypic variances was noted in length of fruits, number of leaves per plant, length of pedicel and girth of the plant.

According to Sree Rangaswamy et al. (1980) the PCV and GCV were high for number of hands per bunch and number of fruits per bunch in dessert varieties but in the case of culinary varieties the characters bunch weight itself followed by number of fruits per bunch exhibited high variation. On the whole a comparison of the magnitude of PCV and GCV for corresponding characters showed that there was not much difference between them for these estimates.

Comparisons made by Nambisan and Rao (1980) between groups of clones showed that there was high variation for all the characters under study between and within groups. The total number of leaves produced per plant, phylacron, leaf area and leaf area duration were distinct for each group of clones.

Pineapple (*Ananas comosus*)

Collins (1968) reported that the numerous varieties of *Ananas comosus* exhibited a wide range of variation in the degree of expression and development of both morphological and physiological characters.

Mathew *et al.* (1979) estimated the genetic variability in pineapple for qualitative and quantitative traits. All the quantitative characters showed significantly wide variation. Phenotypic and genotypic variability and coefficients of variation were high for leaf area, leaf number per plant, fruit weight without corm and fruit length breadth ratio. Environment had a major influence on leaf number per plant.

Studies on varietal variation conducted by Nayar *et al.* (1981) showed significant variation between varieties in number of leaves per plant, leaf area, fruit size, fruit weight with and without crown, length girth ratio, canning ratio and fruit quality.

Grapes (*Vitis* spp.)

Daulta *et al.* (1972) reported high amount of variability with regard to yield per plant, average

bunch weight, fifty berry weight, weight of seeds of twenty berries, sugar-acid ratio and total number of bunches per vine.

Manohar et al. (1975) also recorded high amount of variability for all characters under study. Genotypic coefficients of variation and genetic advance showed appreciable variation under different environments.

3. Heritability and genetic advance

Heritability specifies the proportion of total variability that is due to genetic causes or the ratio of genetic variance to the total variance (Allard, 1960). It indicates the effectiveness with which selection of genotypes can be based on phenotypic performance (Johanson et al., 1955a). They also provide a clear picture of the average effect of genes transmitted from parents to offspring or the extent to which the variability of a quantitative character is transferable to the progeny. Johnson et al.(1955) and Swarup and Chaugle (1962) considered that heritability estimates along with genetic gain were more useful and reliable than heritability estimates alone in predicting the selection response.

Reports on heritability and genetic advance are numerous for the various quantitative characters in a number of cultivated plants, especially in seed propogated ones, but its application in fruit crops, especially in banana is found to be meagre.

In dessert type bananas Nayar *et al.* (1979) reported high heritability values for plant height, leaves per plant, hands and fingers per bunch, fruits per hand, fruit weight, pedicel length and roots per plant. Genetic advance was moderately high for plant height, weight of bunch, hands and fruits per bunch, weight of hands and fingers, fruit length, pedicel length and roots per plant.

In culinary bananas, the heritability estimates showed highest values for number of leaves per plant, girth of the plant, number of fruits per bunch, weight of hands and fruits, length of pedicel and number of roots per plant. The lowest value was noted in the case of plant height followed by number of fruits per bunch. Except in the case of length of fruits, weight of bunch and plant height all the other characters showed higher values for genetic advance. Weight of fruits per bunch and weight of hands showed maximum

genetic advance followed by number of fruits per bunch and girth of plants (Nayar *et al.*, 1980).

Sree Rangaswamy *et al.* (1980) reported high estimates of heritability and genetic advance for number of fruits per bunch, bunch weight andnumber of days to flowering in dessert types and for number of fruits per bunch and number of days to flowering in culinary types. When genetic advance was expressed as percentage of mean, high values were found for number of fruits and hands per bunch and bunch weight.

Pineapple (*Ananas comosus*)

Studies conducted by Mathew *et al.* (1979) in pineapple showed a higher value in heritability for sugar-acid ratio followed by nonreducing sugars. Heritability was minimum for leaf area. The number of leaves per plant, carming ratio and acidity values showed only very low heritability. Genetic advance was high for leaf area followed by number of leaves per plant and fruit weight.

Grapes (*Vitis* spp.)

The estimates of heritability was highest for weight of seeds of twenty berries, followed by percentage

of seeds, fifty berry weight and yield per plant. The expected genetic advance expressed as percentage of mean was the highest for weight of seed of twenty berries followed by fifty berry weight, yield per plant and average bunch weight. The heritability and genetic advance for number of bunches per vine were also very high (Daulta et al., 1972).

Studies of Manohar et al. (1975) showed high heritability for all the characters under study. High heritability value in conjunction with high value of genetic advance was recorded for weight of bunch, yield per vine, weight of berry and TSS/acidity ratio.

In sweet cherry, Hensche et al. (1966) reported high heritabilities (>0.8) for full bloom date, ripe date and fruit firmness, moderate to high (0.3 to 0.6) for first bloom date and fruit diameter, and low (<0.2) for stem length and quality.

In peach, heritabilities were high for ripe date, bloom date, amount of bloom and moderate for fruit firmness and acidity (Hensche et al., 1972).

4. Path coefficient analysis

Yield is the end product of many complex components which singly or jointly influence it (Grafius, 1959 and Whitehouse et al., 1958). Hence it is necessary for a plant breeder to have information on their direct and indirect influences on yield. Wright (1921) developed a technique known as path coefficient analysis which is an effective tool for analysing the direct and indirect causes of information and it also permits critical examination of specific factors that produce a given correlation.

Only very few attempts have been made in this direction in the fruit crops and they are summarised below.

Sree Rangaswamy et al. (1980) reported that bunch length and number of fruits per bunch exhibited high positive direct effect on bunch weight in dessert types, followed by girth of the plant. Other characters had negative direct effects. Number of hands per bunch which had highest negative direct effect expressed its effect via bunch length and number of fruits per bunch.

On the contrary, in the culinary varieties number of hands per bunch had the highest direct effect on bunch weight followed by girth of the plant. Bunch length, number of fruits per bunch and plant height had negative direct effects and their contributions were expressed through number of hands per bunch.

Biswas (1979) conducted path coefficient analysis for pineapple variety Kew. He concluded that fruit breadth and number of days two harvest had very important roles to play in determining fruit weight. But their roles were conflicting. The very high direct effect which number of days for harvest maturity had with fruit weight was counteracted by a similar high negative indirect effect. The major portion of this negative indirect effect was exerted through fruit breadth indicating that the late harvested fruits tended to be smaller in diameter.

Materials and Methods

MATERIALS AND METHODS

The investigations reported herein were carried out at Banana Research Station, Kannara and in the Department of Agricultural Botany, College of Horticulture, Vellanikkara during the period 1981-82.

A. Materials

From among the banana germplasm maintained at the Banana Research Station, Kannara, 48 varieties of diversified origin representing the wide spectrum of variability present in the material, were made use of for the present study.

The list of the varieties with their genomic constitution and country of origin is presented in Table 1.

B. Methods

I. Experimental

A field experiment was laid out in the farm attached to the Banana Research Station, Kannara with the forty eight varieties mentioned above in a

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	Chakkarekadali	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	AAB	Hybrid evolved at Coimbatore South India
24	Padalimoongil	AAB	
25	Palayankodan	AAB	South India
26	Mannan	AAB	-

(Contd.)

Table 1. (Contd.)

Sl. No.	Name of the variety	Genomic group	Country of origin
27	Vennan	AAB	South India
28	Nendravannan	AAB	-
29	Pachanaadan	AAB	South India
30	Sirumalai	AAB	South India
31	Virupakshi	AAB	South India
32	Nota 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	ABB	-
41	Kanchikela	ABB	-
42	Pey Kunnan	ABB	Indo China
43	Pisang awak	ABB	-
44	Peyan	ABB	-
45	Kerpooravalli	ABB	-
46	Ennabenien	ABB	-
47	Kapook	ABB	-
48	Kosthabontha	ABB	Indo China

Randomised Block Design with three replications. Planting was done in pits of size 50 cm^3 at a spacing of 2.15 m either way and 3 m between blocks. The suckers were collected from the varietal collection available at the station and were planted on 2nd August 1981. Uniform cultural operations and crop management practices were adopted during the cropping season. Urea, Factumphos and muriate of potash were applied to supply NPK at the rate of 200:200:400 g per plant in two equal split doses, two months and four months after planting over a basal dressing of green leaf at the rate of 10 kg per plant. The experimental plots were carefully maintained with timely spraying, earthing up, irrigation propping, etc. Border rows of the variety Palayankodan were grown all around in each of the three replications to avoid any border effect and also to ensure protection to the experimental crop.

Observations on the following 18 characters were recorded from all the plants in the three replications.

a) Plant characters

1. Height of pseudostem at shooting time (cm)
2. Girth at the base of pseudostem at shooting time (cm)

3. Number of leaves per plant at shooting time (functional leaves)
4. Total number of leaves per plant
5. Leaf area (m^2)
6. Length of petiole (cm)
7. Width of petiole canal (cm)
8. Phylacron (the time interval for the production of two successive leaves) (days)
9. Length of pedicel (cm)
10. Duration of the crop (days)

b) Bunch characters

11. Number of hands per bunch
12. Number of fingers per hand
13. Length of individual finger (cm)
14. Girth of individual finger (cm)
15. Weight of individual finger (g)
16. Total number of fingers per bunch
17. Bunch length (cm)
18. Bunch weight (kg)

The following procedures were adopted in taking observations on the various characters studied.

a) Plant characters

1. Height of pseudostem at shooting time

The height of the plant was measured in cm from

the base of the pseudostem to the axil of the youngest leaf at shooting time.

2. Girth at the base of pseudostem at shooting time

Girth of the pseudostem was measured in cm at 20 cm from the ground level at shooting time.

3. Number of leaves per plant at shooting time (functional leaves)

Fully opened functional leaves present at the time of flowering were counted.

4. Total number of leaves per plant

Total number of leaves produced by the plant from planting to flowering was recorded (juvenile stages excluded).

5. Leaf area

Area of the third leaf in m^2 at the time of flowering was calculated using the formula given by Murray (1960) and Obiefuna and Ndubizu (1979) (leaf area = length x breadth x 0.8). Lamina length was measured from its base to the tip and width at the broadest point in the middle region of the leaf.

6. Length of petiole

Petiole length was measured in cm from pseudostem to base of lamina of the third leaf.

7. Width of petiole canal

Width of petiole canal was measured in cm at 5 cm below the base of lamina of the third leaf.

8. Phyllocron

The time interval in days for the production of two successive leaves was recorded.

9. Length of pedicel

Length of pedicel was measured in cm from the point of attachment of the finger to the peduncle, to the base of the finger.

10. Duration of the crop

The number of days taken from planting to harvest were recorded as duration of the crop.

b) Bunch characters

The bunches were harvested when they were fully mature as indicated by the disappearance of the ridges

on the fingers, i.e. when the fingers became "round full" (Simmonds, 1959). The following observations were made on the bunches.

11. Number of hands per bunch

The total number of hands in a bunch was counted.

12. Number of fingers per hand

The total number of fingers in the second hand from the base was counted.

13. Length of individual finger

The length from the point of attachment to the tip of the middle finger of the top row in the second hand from the base of the bunch as suggested by Gottreich et al. (1964) was measured in cm.

14. Girth of individual finger

Girth of the same finger which was used for length measurement was measured in cm.

15. Weight of individual finger

The finger which was used for length and girth measurement was weighed in a top loading balance and the weight was recorded in g.

16. Total number of fingers per bunch

The number of fingers in the whole bunch was counted.

17. Bunch length

The length of individual bunch was measured in cm from the point of attachment of the first hand to that of the last hand.

18. Bunch weight

The individual bunch was weighed on a plat form balance and weight recorded in kg.

II. Statistical analysis

Data on different characters studied were subjected to statistical analysis. The analysis of variance technique for randomised block design was employed for the estimation of various genetic parameters. The extent of association among characters, was measured by correlation coefficients. Path coefficient analysis was used for estimating the direct and indirect effects of various characters on yield. A selection index was worked out using discriminant function technique.

The details of the statistical analysis followed in the present experiment are as follows.

1. Analysis of variance

The model utilised in the analysis of this design is

$$Y_{ij} = \bar{x} + b_i + t_j + e_{ij}, \quad i = 1 \ldots 3, \quad j = 1 \ldots 48$$

where

Y_{ij} = performance of j^{th} genotype in i^{th} block

$\bar{x}$ = general mean

b_i = true effect of i^{th} block

t_j = true effect of j^{th} genotype and

e_{ij} = random error

2. Estimation of variability, heritability, expected genetic advance and genetic gain

Variability

Estimates of variance components were obtained by using the following formula as suggested by Burton (1952). The formulae used in the estimation of variability at genotypic, phenotypic and environmental levels are given below.

a) Phenotypic variance (Vp) = (Vg) + (Ve)

where (Vg) = genotypic variance

(Ve) = environmental variance

b) Genotypic variance (Vg) = $\frac{MSv - MSe}{r}$

where MSv = varietal mean square

MSe = environmental mean square

r = number of replications

c) Environmental variance (ve)

d) Phenotypic coefficient of variation (PCV) = $\sqrt{\frac{(VP) \times 100}{\bar{x}}}$

where $\bar{x}$ = mean of the character under study

e) Genotypic coefficient of variation (GCV) = $\sqrt{\frac{(Vg) \times 100}{\bar{x}}}$

f) Environmental coefficient of variation (ECV) = $\sqrt{\frac{(Ve) \times 100}{\bar{x}}}$

Heritability

Heritability in the broad sense was estimated by using the following formula as suggested by Burton and Devane (1953).

$$\text{Heritability (H)} = \frac{(Vg) \times 100}{(Vp)}$$

Expected genetic advance

The expected genetic advance (GA) of the available germplasm was measured by using the formula suggested by

Lush (1949) and Johnson et al. (1955a).

$$GA = \frac{(Vg) \times K}{\sqrt{(Vp)}}$$

K = Standardised selection differential

Expected genetic gain

The expected genetic advance expressed as percentage of mean is the expected genetic gain.

$$\text{i.e. Expected genetic gain (GG)} = \frac{GA \times 100}{\bar{x}}$$

where GA = expected genetic advance
$\bar{x}$ = mean of the character under study

3. Estimation of correlations

Phenotypic and genotypic covariances were worked out in the same way as variances were calculated. The different covariance estimates were calculated by the method suggested by Fisher (1954).

Phenotypic covariance between characters i and j

$$COV_{p_{ij}} = COV_{g_{ij}} + COV_{e_{ij}}$$

where $COV_{g_{ij}}$ = genotypic covariance between characters i and j
$COV_{e_{ij}}$ = environmental covariance between characters i and j

$$COV_{g_{ij}} = \frac{MSP_{v_{ij}} - MSP_{e_{ij}}}{r}$$

where $MSP_{v_{ij}}$ = Mean varietal sum of products of character i and j

$MSP_{e_{ij}}$ = Mean error sum of products of character i and j

r = number of replications

Phenotypic and genotypic correlation coefficients among the various characters were worked out in all possible combinations according to the formula suggested by Johnson et al. (1955b)

Phenotypic correlation coefficient between characters i and j

$$r_{p_{ij}} = \frac{COV_{p_{ij}}}{\sqrt{V_{p_i} \times V_{p_j}}}$$

where V_{p_i} = phenotypic variance of character i

V_{p_j} = phenotypic variance of character j

Genotypic correlation coefficient between characters i and j

$$r_{g_{ij}} = \frac{COV_{g_{ij}}}{\sqrt{V_{g_i} \times V_{g_i}}}$$

where V_{g_i} = genotypic variance of character i

V_{g_j} = genotypic variance of character j

Path coefficient analysis

Path coefficients are standardised regression coefficients. In path coefficient analysis the correlations among cause and effect are partitioned into direct and indirect effects of causal factors on an effect factor. The principles and techniques suggested by Wright (1921), Li (1955) and Duvey and Lu (1959) for cause and effect system were adopted for the analysis. The characters having significant correlation with yield at one per cent level were selected and accordingly such of these characters having maximum correlation viz., number of hands per bunch, weight of individual finger, girth of individual finger, girth at the base of pseudostem, total number of leaves per plant, leaf area, bunch length and total number of fingers per bunch were considered for the path coefficient analysis.

Residual factor which measures the contribution of rest of the characters not considered in the causal scheme was also estimated.

Estimation of selection indices

The selection indices were obtained by discriminant function analysis. Three sets of characters were

used for finding out the selection indices. The component characters in one set were number of hands per bunch, bunch length, total number of fingers per bunch and weight of individual finger. These characters were selected based on the relative magnitude of positive direct effects on yield per plant. The statistical method suggested by Robinson et al. (1951) was used for constructing selection indices and computing genetic advance. The set of simultaneous equations solved to obtain weights in the selection index based on yield and the independent component characters were

$$b_1t_{11} + b_2t_{12} + b_3t_{13} + \ldots\ldots + b_kt_{1k} + b_yt_{1y} = g_{1y}$$
$$b_1t_{21} + b_2t_{22} + b_3t_{23} + \ldots\ldots + b_kt_{2k} + b_yt_{2y} = g_{2y}$$
$$b_1t_{31} + b_2t_{32} + b_3t_{33} + \ldots\ldots + b_kt_{3k} + b_yt_{3y} = g_{3y}$$
$$\vdots$$
$$b_1t_{k1} + b_2t_{k2} + b_3t_{k3} + \ldots\ldots + b_kt_{kk} + b_yt_{ky} = g_{ky}$$

Where t_{kk} and t_{ky} represent phenotypic variance and covariance respectively and b_k is the unknown weight. g_{ky} and g_{kk} are genotypic covariance and variance respectively.

In the second set the dependent character yield also was included for the estimation of index and in the third case all the nine characters considered for path coefficient analysis were used for finding out the selection index.

$$GA(D) = i\,(\Sigma b_k g_{ky})^{\frac{1}{2}}$$ where i

stands for intensity of selection when top 5 per cent of the population is selected (2.06).

Genetic advance by straight selection for yield

$$GA(s) = i \cdot \frac{g_{yy}}{(t_{yy})^{\frac{1}{2}}}$$

The relative efficiency of selection through discriminant function over straight selection was calculated as suggested by Paroda and Joshi (1970).

Relative efficiency over straight selection

$$= \frac{GA(D) - GA(s)}{GA(s)} \times 100$$

Analysis of genetic divergence through metroglyph method

Anderson (1957) proposed this method to study the pattern of morphological variation in parents and hybrids. In the present study 48 banana genotypes were analysed in a replicated trial and the measurements on various characters were recorded. From the data mean

tables were prepared where, each value was the mean over replications.

Two most variable characters were selected, one of them was taken along the X axis and the other on the Y - axis. The means of Y values were plotted against the means of X values for each genotype. A particular genotype was thus represented by a glyph on the graph.

The other characters were represented by rays on the glyph, the rays for same character having the same position on each glyph.

The range of variation in each character was represented by different length of rays i.e. a genotype having low values for the character will have a small ray and so on. Thus the length of the ray is either short, medium or long depending on the magnitude of values.

Results

RESULTS

The data collected from all the 48 varieties with respect to 18 economic characters have been statistically analysed and the results are presented under the following heads.

Estimation of variability, heritability and expected genetic advance

Observations on the behaviour of 48 banana varieties with reference to 18 characters viz., height of pseudostem at shooting time (in cm), girth at the base of pseudostem at shooting time (in cm), number of leaves per plant at shooting time, total number of leaves per plant, leaf area (in m^2), length of petiole (in cm), width of petiole canal (in cm), phylacron (in days), length of pedicel (in cm), duration of the crop (in days), number of hands per bunch, number of fingers per hand, length of individual finger (in cm), girth of individual finger (in cm), weight of individual finger (in g), total number of fingers per bunch, bunch length (in cm), and bunch weight (in kg), have been made from all the plants in the three replications. The data are presented in Tables 2 to 19.

The range, mean and standard error of mean for the different characters are presented in Table 20. The phenotypic, genotypic and environmental variances for the different characters have been presented in Table 21. Table 22 presents the phenotypic, genotypic and environmental coefficients of variation for the different characters. In Table 23 heritability, expected genetic advance and genetic gain for the different characters are furnished. Table 24 gives phenotypic, genotypic and environmental correlations between bunch weight and other characters. Genotypic and phenotypic correlation coefficients among eight selected component characters are presented in Table 25. In Table 26 the direct and indirect genotypic effects of eight component characters on yield are furnished.

The analysis of variance conducted for the 18 economic characters is presented in Appendix-1. Appendix-2 gives the genotypic and phenotypic variances and covariances for the eight selected component characters on yield.

Height of pseudostem at shooting time (in cm)

The mean values pertaining to this character

in respect of 48 varieties are presented in Table 2.

(TABLE 2)

From the data presented above, it is seen that the mean values for height of pseudostem among the varieties ranged from 137.5 cm in Nemarai belonging to AA genomic group to 421.83 cm in Kapoor with ABB genomic constitution. General mean for the character was 306.98 cm. The analysis of variance showed that there was significant difference among the varieties for this character. (Appendix-1).

Genetic component of variance for this character was found to be high (Vp = 4184.22, Vg = 3547.48, Ve = 636.73 (Table 21) with high heritability and genetic gain (H = 84.7%, GG = 36.8%) (Table 23). The genotypic and phenotypic coefficients of variation were 19.34 and 21.00 per cent respectively (Table 22).

Girth at the base of pseudostem at shooting time (in cm)

Mean values of girth of pseudostem are presented in Table 3.

(TABLE 3)

Girth at the base of pseudostem was highest (88 cm) for the variety Kosthabontha having ABB genome

Table 2. Ranking of the varieties for height of pseudostem at shooting time (in cm)

Sl. No.	Name of the variety	Genomic group	Mean value
1	Kapook	ABB	421.83
2	Kosthabontha	ABB	412.00
3	Peyan	ABB	402.00
4	Pisang awak	ABB	385.67
5	Ney poovan	AB	361.67
6	Kanchikela	ABB	355.67
7	Mulanthuruthy Nendran	AAB	355.33
8	Motta poovan	AAB	354.00
9	Ambalakadali	AB	352.70
10	Njali poovan	AB	351.33
11	Adakka Kunnan	AB	350.00
12	Bugnan	--	349.50
13	Gros Michel	AAA	347.00
14	Thaen Kunnan	AB	339.27
15	Ennabenian	ABB	338.00
16	Cheenabale	--	334.00
17	Pey Kunnan	ABB	331.00
18	Karpooravalli	ABB	329.00
19	Manoranjitham	AAA	328.50
20	Poovan Kunnan	AB	327.67
21	H-135	AAB	324.67
22	Nallachakkarakeli	AAA	322.50
23	Suwandel	AAB	321.67
24	Nendran	AAB	320.33
25	Nendravannan	AAB	316.00
26	Sirumalai	AAB	315.00
27	Chenganassery Nendran	AAB	313.67
28	Nendra Kunnan	AB	313.00

(Contd.)

Table 2. (Contd.)

Sl. No.	Name of the variety	Genomic group	Mean value
29	Dakshineagar	ABB	313.00
30	Virupakshi	AAB	312.33
31	Lady's finger	AAB	310.00
32	Padalimoongil	AAB	306.67
33	Palayankodan	AAB	306.67
34	Vaman	AAB	306.67
35	Pacha chingan	AAB	305.67
36	Mannan	AAB	303.17
37	Karimkadali	AAB	288.00
38	Pachanadan	AAB	287.33
39	Chakkarakadali	AB	277.33
40	Kunnan	AB	258.10
41	Adukkan	AB	245.00
42	Robusta	AAA	234.50
43	Valiyakunnan	AB	229.00
44	Pisang lilin	AA	174.00
45	Vamanakeli	AAA	161.67
46	Mauritius	AAA	157.33
47	Dwarf Cavendish	AAA	148.33
48	Namarai	AA	137.50

General mean: 306.98

C.D. : 29.254

Table 3. Ranking of the varieties for girth at the base of pseudostem at shooting time (in cm)

Sl. No.	Name of the variety	Genomic group	Mean value
1	Kosthabontha	ABB	88.00
2	Peyan	ABB	81.33
3	Pisang awak	ABB	80.00
4	Kapook	ABB	79.50
5	Gros Michel	AAA	76.33
6	Kunnchikela	ABB	76.13
7	Karpooravalli	ABB	75.50
8	Bugnan	--	73.87
9	Pachanaadan	AAB	71.33
10	Poocha Kunnan	AB	70.33
11	H-135	AAB	70.10
12	Adakka Kunnan	AB	70.00
13	Njali poovan	AB	59.33
14	Pey Kunnan	ABB	69.17
15	Nallachakkarakeli	AAA	69.00
16	Suvandel	AAB	69.00
17	Nendra Kunnan	AB	68.93
18	Cheenabale	--	68.67
19	Dakshinsagar	ABB	68.33
20	Lady's finger	AAB	67.90
21	Pachachingan	AAB	67.67
22	Thaen Kunnan	AB	67.17
23	Palayankodan	AAB	66.67
24	Virupakshi	AAB	66.67
25	Ambalakadali	AB	66.17
26	Kunnen	AB	65.77

(Contd.)

Table 3. (Contd.)

Sl. No.	Name of the variety	Genomic group	Mean Value
27	Vamanakeli	AAA	65.00
28	Robusta	AAA	65.00
29	Mauritius	AAA	65.00
30	Motta poovan	AAB	64.93
31	Ennabenian	ABB	64.83
32	Ney poovan	AB	64.77
33	Manoranjitham	AAA	64.00
34	Mulanthuruthy Nendran	AAB	64.00
35	Mannan	AAB	63.93
36	Sirumalai	AAB	63.67
37	Nendravannan	AAB	63.50
38	Karimkadali	AAB	62.67
39	Vannan	AAB	62.67
40	Nendran	AAB	61.17
41	Dwarf Cavendish	AAA	61.00
42	Chakkarakadali	AB	60.87
43	Padalimoongil	AAB	59.33
44	Chenganassery Nendran	AAB	58.67
45	Valiya Kunnan	AB	55.67
46	Adukkan	AB	50.00
47	Pisang lilin	AA	46.10
48	Namarai	AA	27.33

General mean : 66.19
C.D. : 6.167

and lowest for the variety Namarai (27.33 cm) with a general mean of 66.19 cm. The varieties showed significant difference with reference to this character (Appendix-1).

Major part of the variance for this character was found to be genetic (Vp = 99.27, Vg = 81.16, Ve = 18.11) as is seen from Table 21. The phenotypic and genotypic coefficients of variation were 15.07 and 13.63 per cent respectively (Table 22). The character showed a high heritability of 81.76 per cent and genetic advance as percentage of mean was 25.37 (Table 23).

Number of leaves per plant at shooting time

Mean values pertaining to number of leaves per plant at shooting time are presented in Table 4.

(TABLE 4)

The highest number of functional leaves per plant (20.67) was recorded by Kosthabontha of the ABB genomic group and the lowest number (9.67) was for the variety Namarai with AA genome, the general mean being 15.92 (Table 4). There was significant difference between varieties for this character (Appendix-1).

Table 4. Ranking of the varieties for number of leaves per plant at shooting time

Sl. No.	Name of the variety	Genomic Group	Mean value
1	Kosthabontha	ABB	20.67
2	Poyan	ABB	20.33
3	Manoranjitham	AAA	20.00
4	Ambalakadali	AB	19.33
5	Vamanakeli	AAA	19.33
6	Njali poovan	AB	18.67
7	Karimkadali	AAB	18.00
8	Ney poovan	AB	18.00
9	Pisang awak	ABB	18.00
10	Nendravannan	AAB	17.67
11	Ennabenian	ABB	17.67
12	Kapook	ABB	17.33
13	Pey Kunnan	ABB	17.33
14	Kunnan	AB	17.33
15	Suvandel	AAB	17.33
16	Dakshinsagar	ABB	17.00
17	Karpooravalli	ABB	17.00
18	Adukkan	AB	17.00
19	Mauritius	AAA	17.00
20	Mulanthuruthy Nendran	AAB	16.33
21	Sirumalai	AAB	16.33
22	Nallachakkarakeli	AAA	16.00
23	Padalimoongil	AAB	16.00
24	Pachanaadan	AAB	16.00
25	Cheenabale	--	16.00
26	Palayankodan	AAB	15.67

(Contd.)

Table 4. (Contd.)

Sl. No.	Name of the variety	Genomic group	Mean Value
27	Valiya Kunnan	AB	15.67
28	H-135	AAB	15.33
29	Kannan	AAB	15.33
30	Vannan	AAB	15.33
31	Virupakshi	AAB	15.33
32	Poocha Kunnan	AB	15.33
33	Dugnan	--	15.33
34	Robusta	AAA	15.00
35	Pacha chingan	AAB	14.67
36	Lady's finger	AAB	14.67
37	Motta poovan	AAB	14.67
38	Thaen Kunnan	AB	14.67
39	Nendran	AAB	14.67
40	Kanchikela	ABB	14.67
41	Nendra Kunnan	AB	13.33
42	Chakkarakadali	AB	13.00
43	Dwarf Cavendish	AAA	13.00
44	Gros Michel	AAA	13.00
45	Adakka Kunnan	AB	12.00
46	Chenganessery Nendran	AAB	12.00
47	Pisang lilin	AA	10.33
48	Namarai	AA	9.67

General mean : 15.92
C.D. : 2.242

The genetic component of variance for the character was high (Vp = 6.84, Vg = 4.88, Ve = 1.96) (Table 21) with high heritability (H = 71.33% GG = 24.18%) (Table 23). Phenotypic and genotypic coefficients of variation were 16.39 per cent and 13.85 per cent respectively (Table 22).

Total number of leaves per plant

Table 5 presents the data on total number of leaves per plant.

(TABLE 5)

Peyan recorded the maximum number of leaves per plant (40.33). This is a culinary variety having ABB genomic constitution. The lowest value for number of leaves per plant (20.0) was shown by Namarai (AA) with a general mean of 31.82. The varieties showed significant difference for this character (Appendix-1).

The phenotypic, genotypic and environmental variances were Vp = 14.08, Vg = 11.03 and Ve = 3.05 respectively (Table 21) and the corresponding coefficients of variation were PCV = 11.66 per cent, GCV = 10.32 per cent and ECV = 5.43 per cent (Table 22). The character showed a high heritability of 78.33 per cent

Table 5. Ranking of the varieties for total number of leaves per plant

Sl. No.	Name of the variety	Genomic group	Mean value
1	Poyan	ABB	40.33
2	Kosthabontha	ABB	39.33
3	Dakshinsagar	ABB	36.67
4	Kapook	ABB	36.33
5	Ambalakadali	AB	36.33
6	Hey poovan	AB	36.33
7	Njali poovan	AB	35.67
8	Kunnan	AB	34.67
9	Mauritius	AAA	34.67
10	Pisang awak	ABB	34.33
11	Karimkadali	AAB	34.00
12	Mulanthuruthy Nendran	AAB	34.00
13	Adukkan	AB	33.67
14	Kanchikela	ABB	33.67
15	Virupakshi	AAB	33.33
16	Pey Kunnan	ABB	33.33
17	Ennabenlen	ABB	33.33
18	Vamanakeli	AAA	33.00
19	Vannan	AAB	33.00
20	Bugnan	--	33.00
21	Cheenabale	--	32.67
22	Karpooravalli	ABB	32.67
23	Thaen Kunnan	AB	32.67
24	Nendran	AAB	32.67
25	Robusta	AAA	32.67
26	Gros Michel	AAA	32.67

(Contd.)

Table 5. (Contd.)

Sl. No.	Name of the variety	Genomic group	Mean value
27	Manoranjitham	AAA	32.67
28	H-135	AAB	32.67
29	Lady's finger	AAB	32.33
30	Suwandel	AAB	32.33
31	Nendravannan	AAB	32.00
32	Nallachakkarakeli	AAA	31.67
33	Sirumalai	AAB	31.00
34	Padalimoongil	AAB	30.67
35	Manman	AAB	30.67
36	Changalassery Nendran	AAB	30.67
37	Pacha chingan	AAB	30.67
38	Palayankodan	AAB	30.00
39	Pachanaadan	AAB	30.00
40	Nendra Kunnan	AB	30.00
41	Motta poovan	AAB	29.67
42	Poocha Kunnan	AB	29.67
43	Dwarf Cavendish	AAA	28.67
44	Valiya Kunnan	AB	27.67
45	Chekkarakadali	AB	27.33
46	Adakka Kunnan	AB	27.00
47	Pisang lilin	AA	25.00
48	Namarai	AA	20.00

General mean : 31.82
C.D. : 2.794

but the genetic gain was only 19.04 per cent (Table 23).

Leaf area(in m^2)

Mean values for the leaf area of 48 varieties studied are presented in Table 6.

(TABLE 6)

The variety Kapook with ABB genome recorded the highest leaf area of 2.02 m^2. The lowest leaf area (0.3 m^2) was for the variety Namarai (AA) with a general mean of 1.17 m^2. The varieties showed significant difference for leaf area (Appendix-1).

The genetic component of the total variance was high viz., Vp = 0.09, Vg = 0.07, Ve = 0.03 (Table 21). The phenotypic and genotypic coefficients of variation were 25.51 and 21.71 per cent respectively (Table 22). Heritability and genetic gain for the character were also moderately high (H = 72.44% and GG = 38.46%) (Table 23).

Length of petiole (in cm)

Table 7 presents the mean values for length of petiole.

(TABLE 7)

Table 6. Ranking of the varieties for leaf area (in m^2)

Sl. No.	Name of the variety	Genomic group	Mean value
1	Kapoor	ABB	2.02
2	Kosthabontha	ABB	1.77
3	Nallachakkarakeli	AAA	1.53
4	Peyan	ABB	1.49
5	Ambalakadali	AB	1.43
6	Gros Michel	AAA	1.41
7	Pey Kunnan	ABB	1.39
8	Poocha Kunnan	AB	1.39
9	Manoranjithan	AAA	1.37
10	Dakshinsagar	ABB	1.36
11	Pisang awak	ABB	1.35
12	Thaen Kunnan	AB	1.35
13	Bugman	--	1.33
14	Adakkakunnan	AB	1.33
15	Kunnan	AB	1.33
16	Karpooravalli	ABB	1.29
17	Mannan	AAB	1.29
18	Robusta	AAA	1.29
19	Cheenabale	--	1.28
20	Ney poovan	AB	1.27
21	Nendravannan	AAB	1.24
22	Kanchikela	ABB	1.23
23	Motta poovan	AAB	1.22
24	Mulanthuruthy Nendran	AAB	1.21
25	Njali poovan	AB	1.21
26	Ennabenian	ABB	1.21

(Contd.)

Table 6. (Contd.)

Sl. No.	Name of the variety	Genomic group	Mean value
27	Chokkarkadali	AB	1.19
28	Pacha chingan	AAB	1.19
29	Suvandel	AAB	1.17
30	Adukkan	AB	1.16
31	Karinkadali	AAB	1.15
32	Padalimoongil	AAB	1.13
33	Palayankodan	AAB	1.13
34	H-135	AAB	1.12
35	Vennan	AAB	1.07
36	Vamanakeli	AAA	1.04
37	Nendra Kunnan	AB	1.03
38	Changanassery Nendran	AAB	1.03
39	Mauritus	AAA	1.02
40	Sirumalai	AAB	1.01
41	Virupakshi	AAB	0.98
42	Pachanandan	AAB	0.95
43	Dwarf Cavendish	AAA	0.93
44	Nendran	AAB	0.90
45	Lady's finger	AAB	0.81
46	Valiya Kunnan	AB	0.71
47	Pisang lilin	AA	0.56
48	Namarai	AA	0.30

General mean : 1.17
C.D. : 0.227

Table 7. Ranking of the varieties for length of the petiole (in cm)

Sl. No.	Name of the variety	Genomic group	Mean value
1	Ambalakadali	AB	76.87
2	Poocha Kunnan	AB	73.33
3	Adakka Kunnan	AB	71.00
4	Suvandel	AAB	65.50
5	Theen Kunnan	AB	64.07
6	Kapook	ABB	63.50
7	Pisang awak	ABB	63.00
8	Kunnan	AB	63.00
9	Ney poovan	AB	61.67
10	Nallachakkarake	AAA	59.00
11	Karpooravalli	ABB	58.00
12	Chakkarakadali	AB	57.00
13	H-135	AAB	56.83
14	Njali poovan	AB	56.00
15	Peyan	ABB	55.33
16	Kosthabontha	ABB	55.33
17	Palayankodan	AAB	55.33
18	Bugnan	--	55.00
19	Motta poovan	AAB	54.67
20	Nendravannan	AAB	54.50
21	Pisang lilin	AA	54.27
22	Padalimoongil	AAB	53.50
23	Manoranjitham	AAA	52.83
24	Kanchikela	ABB	52.67
25	Ennabenian	ABB	52.33
26	Dakshinsagar	ABB	51.67

(Contd.)

Table 7 (Contd.)

Sl. No.	Name of the variety	Genomic group	Mean value
27	Valiya Kunnan	AB	50.67
28	Virupakshi	AAB	50.33
29	Cheenabale	--	50.00
30	Pey Kunnan	ABB	50.00
31	Pacha chingan	AAB	48.47
32	Vannan	AAB	47.83
33	Adukkan	AB	46.67
34	Mannan	AAB	46.60
35	Sirumalai	AAB	46.23
36	Milanthuruthy Nendran	AAB	45.50
37	Pachanaadan	AAB	45.00
38	Lady's finger	AAB	44.50
39	Nendra Kunnan	AB	44.50
40	Changanassery Nendran	AAB	42.00
41	Nendran	AAB	40.10
42	Karimkadali	AAB	39.93
43	Robusta	AAA	36.67
44	Namarai	AA	33.00
45	Gros Michel	AAA	31.00
46	Mauritius	AAA	27.70
47	Dwarf Cavendish	AAA	24.07
48	Vamanakeli	AAA	18.50

General mean : 50.9
C.D. : 8.424

From the table it can be seen that the character showed a wide range of variability from 18.5 cm in Vamanakeli with AAA genome to 76.87 cm in Ambalakadali with AB genome, general mean being 50.9 cm. The analysis of variance revealed significant difference among the varieties for this character (Appendix-1).

The total variance for this character among the 48 varieties studied was 173.93 which could be partitioned into 115.99 due to genetic causes and 57.99 due to environmental causes (Table 21). Phenotypic, genotypic and environmental coefficients of variation were 25.70, 20.99 and 14.84 per cent respectively (Table 22). Petiole length has got a medium heritability of 66.67 per cent and genetic gain of 35.60 per cent respectively (Table 23).

Width of petiole canal (in cm)

Table 8 shows the mean values for width of petiole canal.

(TABLE 8)

The character showed a range from 1 cm to 5 cm. In general, varieties belonging to AAA genomic group (Vamanakeli, Robusta, Mauritius, Dwarf Cavendish and

Table 8. Ranking of the varieties for width of petiole canal (in cm)

Sl. No.	Name of the variety	Genomic group	Mean value
1	Vamanakeli	AAA	5.00
2	Robusta	AAA	5.00
3	Mauritius	AAA	5.00
4	Dwarf Cavendish	AAA	5.00
5	Gros Michel	AAA	5.00
6	Chakkarakadali	AB	4.00
7	Manoranjitham	AAA	4.00
8	Karimkadali	AAB	4.00
9	Adukkan	AB	4.00
10	Njali poovan	AB	4.00
11	H-135	AAB	4.00
12	Pacha chingan	AAB	3.33
13	Ney poovan	AB	3.00
14	Nallachakkarakeli	AAA	3.00
15	Palayankodan	AAB	3.00
16	Mannan	AAB	3.00
17	Nendravannan	AAB	3.00
18	Pachanaadan	AAB	3.00
19	Sirumalai	AAB	3.00
20	Virupakshi	AAB	3.00
21	Lady's finger	AAB	3.00
22	Nendra Kunnan	AB	3.00
23	Thaen Kunnan	AB	3.00
24	Ennabenian	ABB	3.00
25	Ambalakadali	AB	2.00
26	Namarai	AA	2.00

(Contd.)

Table 8. (Contd.)

Sl. No.	Name of the variety	Genomic group	Mean value
27	Pisang lilin	AA	2.00
28	Kunnan	AB	2.00
29	Padalimoongil	AAB	2.00
30	Vannan	AAB	2.00
31	Motta poovan	AAB	2.00
32	Suwandel	AAB	2.00
33	Adakkakunnan	AB	2.00
34	Poocha Kunnan	AB	2.00
35	Valiya Kunnan	AB	2.00
36	Nendran	AAB	2.00
37	Mulanthuruthy Nendran	AAB	2.00
38	Changenassery Nendran	AAB	2.00
39	Cheenabale	--	2.00
40	Peyan	ABB	2.00
41	Karpooravalli	ABB	2.00
42	Kapook	ABB	2.00
43	Kosthabontha	ABB	2.00
44	Dakshinsagar	ABB	1.00
45	Bugnan	--	1.00
46	Kanchikela	ABB	1.00
47	Pey Kunnan	ABB	1.00
48	Pisang awak	ABB	1.00

General mean : 2.74

C.D. : 0.270

and Gros Michel) recorded the highest value (5 cm) and those having ABB genome (Kanchikela, Peykunnan and Pisang awak) recorded lowest value of 1 cm. General mean was 2.74 cm. The varietal differences were significant for width of petiole canal (Appendix-1).

Phenotypic variance for the character was 1.26 of which 1.19 was genotypic and 0.07 environmental (Table 21), thereby showing a low environmental influence on this character. Phenotypic and genotypic coefficients of variation were 41.95 and 40.76 per cent respectively (Table 22). Heritability and genetic advance as percentage of mean were 91.44 per cent and 79.93 per cent respectively (Table 23).

Phylacron (in days)

Mean values of phylacron for the 48 varieties studied are presented in Table 9.

(TABLE 9)

Data presented in Table 9 showed that the mean values ranged from 9.19 days in Nemarai with AA genome to 6.41 days in Njalipoovan with AB genome. The general mean for the character was 7.75 days. There was significant difference between varieties for this character (Appendix-1).

Table 9. Ranking of the varieties for phylacron (in days)

Sl. No.	Name of the variety	Genomic group	Mean value
1	Namarai	AA	9.19
2	Robusta	AAA	9.10
3	Motta poovan	AAB	8.62
4	Monnan	AAB	8.57
5	Pachanaadan	AAB	8.48
6	Poocha Kunnan	AB	8.48
7	H-135	AAB	8.47
8	Pacha chingan	AAB	8.46
9	Peyan	ABB	8.45
10	Palayankodan	AAB	8.39
11	Vaman	AAB	8.33
12	Valiya Kunnan	AB	8.31
13	Sirumalai	AAB	8.26
14	Cheenabale	--	8.19
15	Adakka Kunnan	AB	8.14
16	Thaen Kunnan	AB	8.09
17	Dwarf Cavendish	AAA	8.08
18	Virupakshi	AAB	8.06
19	Lady's finger	AAB	8.05
20	Adukkan	AB	8.03
21	Kopook	ABB	7.89
22	Vamankeli	AAA	7.88
23	Piseng lilin	AA	7.80
24	Padalimoongil	AAB	7.80
25	Nendra Kunnan	AB	7.72
26	Manoranjitham	AAA	7.64

(Contd.)

Table 9. (Contd.)

Sl. No.	Name of the variety	Genomic group	Mean value
27	Ennabenian	ABB	7.51
28	Pey Kunnan	ABB	7.50
29	Nellachakkarakeli	AAA	7.49
30	Nendravannan	AAB	7.49
31	Dugnan	--	7.40
32	Kunnan	AB	7.40
33	Karimkadali	AAB	7.38
34	Mauritius	AAA	7.28
35	Kanchikela	ABB	7.24
36	Nendran	AAB	7.22
37	Dakshinsagar	ABB	7.21
38	Milanthuruthy Nendran	AAB	7.16
39	Ambalakadali	AB	7.13
40	Karpooravalli	ABB	7.12
41	Changanassery Nendran	AAB	7.11
42	Pisang awak	ABB	7.11
43	Chakkarakadali	AB	7.07
44	Suvandel	AAB	7.05
45	Gros Michel	AAA	6.94
46	Ney poovan	AB	6.76
47	Kosthabontha	ABB	6.73
48	Njali poovan	AB	6.41

General mean : 7.75
C.D. : 0.682

The phenotypic, genotypic and environmental variances for the character were 0.53, 0.35 and 0.18 respectively (Table 21) and the corresponding coefficients of variation were 9.41, 7.65 and 5.47 per cent respectively (Table 22). Heritability was relatively low compared to the other characters studied. (H = 66.15%, GG = 12.9%) (Table 23).

Length of pedicel (in cm)

Mean values for length of pedicel are presented in Table 10.

(TABLE 10)

Length of pedicel showed a range from 1.47 cm in Namarai (AA) to 5.8 cm in Padalimoongil (AAB) with a general mean of 3.51 cm. The analysis of variance showed significant difference between the 48 varieties studied for this character (Appendix-1).

The genetic component of variance for the character was high indicating a higher genetic influence on the character (Vp = 0.73, Vg = 0.60, Ve = 0.12) (Table 21). Phenotypic and genotypic coefficients of variation were 24.46 and 22.29 per cent respectively (Table 22). The heritability and expected genetic

Table 10. Ranking of the varieties for length of pedicel (in cm)

Sl. No.	Name of the variety	Genomic group	Mean value
1	Padalimoongil	AAB	5.80
2	Ambalakadali	AB	5.67
3	Mauritius	AAA	4.67
4	Njali poovan	AB	4.57
5	Nallachakkarakeli	AAA	4.43
6	Nendravannan	AAB	4.37
7	Mulanthuruthy Nendran	AAB	4.37
8	Dakshinsagar	ABB	4.33
9	Kunchikela	ABB	4.27
10	Robusta	AAA	4.12
11	Kunnan	AB	4.07
12	Manoranjitham	AAA	4.07
13	Gros Michel	AAA	4.03
14	Dwarf Cavendish	AAA	3.93
15	Adukkan	AB	3.90
16	Poocha Kunnan	AB	3.83
17	Motta poovan	AAB	3.73
18	Peyan	ABB	3.63
19	Vannan	AAB	3.53
20	Ney poovan	AB	3.53
21	Kapook	ABB	3.50
22	Karpooravalli	ABB	3.50
23	Pacha chingan	AAB	3.43
24	Sirumalai	AAB	3.40
25	Nendran	AAB	3.40
26	Palayankodan	AAB	3.37

(Contd.)

Table 10. (Contd.)

Sl. No.	Name of the variety	Genomic group	Mean value
27	Pisang awak	ABB	3.33
28	Kosthabontha	ABB	3.30
29	Cheenabale	--	3.30
30	Changanassery Nendran	AAB	3.30
31	Bugnan	--	3.23
32	Thaen Kunnan	AB	3.23
33	Suwandel	AAB	3.20
34	Virupakshi	AAB	3.03
35	Ennabenian	ABB	3.03
36	Karinkadali	AAB	3.00
37	Vamanakeli	AAA	2.97
38	Lady's finger	AAB	2.97
39	H-135	AAB	2.93
40	Pachanadan	AAB	2.90
41	Nendra Kunnan	AB	2.87
42	Adakka Kunnan	AB	2.83
43	Chakkarakadali	AB	2.77
44	Valiya Kunnan	AB	2.67
45	Pey Kunnan	ABB	2.37
46	Pisang lilin	AA	2.27
47	Mannan	AAB	2.20
48	Namarai	AA	1.47

General mean : 3.51
C.D. : 0.550

gain for the character were also high (H = 83.09%, GG = 41.60%) (Table 23).

Duration of the crop (in days)

Observations regarding duration of the crop from planting to harvest are presented in Table 11.

(TABLE 11)

From the above table, it can be seen that the varieties Adukkan (AB), Pisang awak (ABB), Peyan (ABB), Kapook (ABB) and Kosthabontha (ABB) took maximum number of days (384) to come to harvest; the time taken by Pisang lilin (AA) and Namarai (AA) being the minimum (317.33 days). General mean for duration of the crop was 371.46 days. The varietal differences were significant for duration of the crop (Appendix-1).

The character showed a phenotypic variance of 301.41, of which 262.81 was genotypic and 38.6 environmental (Table 21). Phenotypic and genotypic coefficients of variation were 4.67 and 4.36 per cent respectively (Table 22). The character showed a high heritability of 87.19 per cent but the genetic gain was lowest for this character (GG = 8.4%).Table 23).

Table 11. Ranking of the varieties for duration of the crop (in days)

Sl. No.	Name of the variety	Genomic group	Mean value
1	Adukkan	AB	384.00
2	Pisang awak	ABB	384.00
3	Poyan	ABB	384.00
4	Kapook	ABB	384.00
5	Kosthabontha	ABB	384.00
6	Ambalakadali	AB	383.67
7	Ney poovan	AB	383.33
8	Pey Kunnan	ABB	383.33
9	Thaen Kunnan	AB	383.33
10	Dugnan	--	383.00
11	Njali poovan	AB	383.00
12	Manoranjitham	AAA	382.67
13	Gros Michel	AAA	382.33
14	Padalimoongil	AAB	382.33
15	Vennan	AAB	382.33
16	Adukka Kunnan	AB	382.33
17	Nendra Kunnan	AB	380.67
18	Pacha chingan	AB	380.67
19	Siramalai	AAB	380.33
20	Poocha Kunnan	AB	379.67
21	Ernabenian	ABB	379.33
22	Lady's finger	AAB	379.33
23	Chekkarekadali	AB	379.00
24	Mauritius	AAA	378.67
25	Mannan	AAB	378.67
26	Kanchikela	ABB	378.33

(Contd.)

Table 11. (Contd.)

Sl. No.	Name of the variety	Genomic group	Mean value
27	Pachanaadan	AAB	376.67
28	H-135	AAB	375.33
29	Suvandel	AAB	374.67
30	Motta poovan	AAB	373.33
31	Nallachakkarakeli	AAA	373.00
32	Virupakshi	AAB	372.67
33	Karpooravelli	ABB	372.67
34	Cheenabale	--	371.00
35	Palayankodan	AAB	370.67
36	Dakshinsagar	ABB	370.33
37	Vamanakeli	AAA	369.00
38	Nendravannan	AAB	368.33
39	Mulanthuruthy Nendran	AAB	364.33
40	Changanassery Nendran	AAB	364.33
41	Kunnan	AB	352.00
42	Dwarf Cavendish	AAA	349.33
43	Karinkadali	AAB	346.67
44	Robusta	AAA	346.00
45	Valiyakunnan	AB	340.00
46	Nendran	AAB	339.00
47	Namarai	AA	317.33
48	Pisang lilin	AA	317.33

General mean : 371.46
C.D. : 6.514

Number of hands per bunch

Data pertaining to the number of hands per bunch are presented in Table 12.

(TABLE 12)

From the table given above, it can be seen that among the varieties studied, the maximum number of hands per bunch (14.33) was noted in the case of 3 varieties namely Peykunnan, Pisang awak and Kapoor all belonging to the ABB genomic group and the minimum (3.33) recorded by the variety Padalimoongil having AAB genomic constitution with a general mean of 8.65. The varieties showed significant difference for number of hands per bunch (Appendix-1).

The genetic component of variance for the character was found to be high with a high heritability and genetic gain (V_p = 7.78, V_g = 7.14, V_e = 0.64) (Table 21). (H= 91.75%, GG = 60.92%) (Table 23). Phenotypic and genotypic coefficients of variation were 32.54 per cent and 31.18 per cent respectively (Table 22).

Number of fingers per hand

The mean values of the number of fingers per hand are presented in Table 13.

(TABLE 13)

Table 12. Ranking of the varieties for number of hands per bunch

Sl. No.	Name of the variety	Genomic group	Mean value
1	Pey Kunnan	ABB	14.33
2	Pisang awak	ABB	14.33
3	Kapock	ABB	14.33
4	Kosthabontha	ABB	14.00
5	Kotta poovan	AAB	12.67
6	Palayankodan	AAB	12.00
7	Karpooravalli	ABB	12.00
8	Nallachakkarakeli	AAA	11.67
9	Njali poovan	AB	11.33
10	Neypoovan	AB	11.00
11	Ambalakadali	AB	10.67
12	Mauritius	AAA	10.67
13	Dwarf Cavendish	AAA	10.67
14	Thaen Kunnan	AB	10.67
15	Poocha Kunnan	AB	10.33
16	Kunnan	AB	10.00
17	Robusta	AAA	10.00
18	Peyan	ABB	9.67
19	Adukkan	AB	8.67
20	Adakkakunnan	AB	8.33
21	Kanchikela	ABB	8.33
22	Karimkadali	AAB	8.00
23	Vamanakeli	AAA	8.00
24	Gros Michel	AAA	8.00
25	Ennabenian	ABB	7.67
26	H-135	AAB	7.33

(Contd.)

Table 12. (Contd.)

Sl. No.	Name of the variety	Genomic group	Mean value
27	Pacha chingan	AAB	7.33
28	Chakkarekadali	AB	7.33
29	Choenabale	--	7.33
30	Bugnan	--	7.33
31	Pachanaadan	AAB	7.33
32	Lady's finger	AAB	7.33
33	Suwandel	AAB	7.33
34	Manoranjitham	AAA	7.00
35	Nennan	AAB	7.00
36	Vennan	AAB	7.00
37	Nendravannan	AAB	7.00
38	Virupakshi	AAB	7.00
39	Valiya Kunnan	AB	7.00
40	Nendra Kunnan	AB	7.00
41	Sirumalai	AAB	6.33
42	Dakshinsagar	ABB	6.33
43	Mulanthuruthy Nendran	AAB	5.67
44	Changanassery Nendran	AAB	5.00
45	Pisang lilin	AA	5.00
46	Nendran	AAB	4.67
47	Numarai	AA	4.00
48	Padalimoongil	AAB	3.33

General mean : 8.65
C.D. : 1.209

Table 13. Ranking of the varieties for number of fingers per hand

Sl. No.	Name of the variety	Genomic group	Mean value
1	Nallachakkarakeli	AAA	25.33
2	Kosthabontha	ABB	23.83
3	Motta poovan	AAB	23.00
4	Peyan	ABB	21.67
5	Chakkarakadali	AB	19.00
6	Njali poovan	AB	18.67
7	Pisang awak	ABB	18.67
8	Pey Kunnan	ABB	18.33
9	Palayankodan	AAB	18.00
10	Mauritius	AAA	17.67
11	Adakka Kunnan	AB	17.67
12	Vamanakeli	AAA	17.33
13	Nendra Kunnan	AB	17.33
14	Kapook	ABB	17.33
15	Karpooravalli	ABB	17.00
16	Poocha Kunnan	AB	16.33
17	Pachanaadan	AAB	16.00
18	Ney poovan	AB	15.33
19	Gros Michel	AAA	15.33
20	Vaman	AAB	15.33
21	Nendravannan	AAB	15.00
22	Thaen Kunnan	AB	15.00
23	Pacha chingan	AAB	15.00
24	Ambalakadali	AB	14.33
25	Kunnan	AB	14.33
26	Siramalai	AAB	14.33

(Contd.)

Table 13. (Contd.)

Sl. No.	Name of the variety	Genomic group	Mean value
27	Lady's finger	AAB	14.33
28	Cheenabale	--	14.33
29	Pisang lilin	AA	14.00
30	Adukkan	AB	14.00
31	Virupakshi	AAB	14.00
32	Dugnan	--	14.00
33	Ennabenian	ABB	14.00
34	Robusta	AAA	13.33
35	Dwarf Cavendish	AAA	13.33
36	Valiyakunnan	AB	13.33
37	Kanchikela	ABB	13.33
38	Manoranjitham	AAA	13.00
39	H-135	AAB	13.00
40	Manman	AAB	13.00
41	Suvandel	AAB	13.00
42	Dakshinsagar	ABB	12.67
43	Karinkadali	AAB	12.67
44	Padalimoongil	AAB	10.33
45	Nendran	AAB	10.33
46	Changalasseery Nendran	AAB	10.00
47	Mulanthuruthy Nendran	AAB	10.00
48	Namarai	AA	10.00

General mean : 15.35
C.D. : 2.481

The table presented above shows that the mean value for the character ranged from 25.33 to 10.00 with a general mean of 15.35. The highest number of fingers per hand was observed in the variety Nallachakkarakeli having AAA genome and the lowest number in Namarai (AA). There was significant difference among varieties for this character (Appendix-1).

Phenotypic, genotypic and environmental variances for this character among the varieties were found to be 10.76, 8.61 and 2.15 respectively (Table 21). Phenotypic and genotypic coefficients of variation were 21.64 per cent and 19.36 per cent (Table 22) with high heritability of 80 per cent and expected genetic gain of 35.24 per cent respectively (Table 23).

Length of individual finger (in cm)

Mean values for length of individual finger among the 48 varieties studied are presented in Table 14.

(TABLE 14)

Among the varieties studied the values ranged from 7.9 cm in Namarai (AA) to 22.5 cm in Mulanthuruthy Nendran having AAB genomic constitution with a general mean of 14.62 cm (Table 14). The analysis of variance

Table 14. Ranking of the varieties for length of individual finger (in cm)

Sl. No.	Name of the variety	Genomic group	Mean value
1	Milanthuruthy Nendran	AAB	22.50
2	Vamanakeli	AAA	21.90
3	Nendran	AAB	21.67
4	Kanchikela	ABB	21.67
5	Bugnan	--	21.33
6	Mauritius	AAA	21.00
7	Robusta	AAA	20.93
8	Changanassery Nendran	AAB	20.80
9	Dakshinsagar	ABB	20.33
10	Dwarf Cavendish	AAA	19.67
11	Padalimoongil	AAB	18.60
12	Suwandel	AAB	17.53
13	Karinkadali	AAB	16.73
14	Kunnan	AB	15.90
15	Pisang lilin	AA	15.00
16	Nendravannan	AAB	14.47
17	Gros Michel	AAA	14.33
18	Kapook	ABB	14.23
19	Adukkan	AB	14.20
20	H-135	AAB	13.67
21	Ennabenian	ABB	13.53
22	Pisang awak	ABB	13.43
23	Ney poovan	AB	13.23
24	Pacha chingan	AAB	13.17
25	Valiyakunnan	AB	13.17
26	Mannan	AAB	13.10

(Contd.)

Table 14. (Contd.)

Sl. No.	Name of the variety	Genomic group	Mean value
27	Chakkarakadali	AB	13.07
28	Pey Kunnan	ABB	13.07
29	Nallachakkarakeli	AAA	13.00
30	Kosthabontha	ABB	12.93
31	Lady's finger	AAB	12.43
32	Pachanaadan	AAB	12.33
33	Karpooravalli	ABB	12.20
34	Nendra Kunnan	AB	12.20
35	Adakka Kunnan	AB	12.10
36	Peyan	ABB	12.06
37	Thaen Kunnan	AB	12.03
38	Virupakshi	AAB	12.00
39	Cheenabale	--	11.60
40	Palayankodan	AAB	11.37
41	Ambalakadali	AB	11.33
42	Poocha Kunnan	AB	11.20
43	Manoranjitham	AAA	11.17
44	Vennan	AAB	11.07
45	Sirumalai	AAB	10.83
46	Njali poovan	AB	10.50
47	Motta poovan	AAB	9.33
48	Nenarai	AA	7.90

General mean: 14.62
C.D. : 2.522

showed significant difference between varieties for length of individual finger (Appendix-1).

Major part of the total variance of this character was found to be environmental (Vp = 104.94, Vg = 8.62, Ve = 96.32) (Table 21) indicating the high environmental influence. Phenotypic, genotypic and environmental coefficients of variation also confirmed the above fact (PCV = 66.98%, GCV = 19.20%, ECV = 64.18%) (Table 22). Because of the high environmental influence, heritability and expected genetic gain were low (8.22% and 11.83%) (Table 23).

Girth of individual finger (in cm)

Data pertaining to the mean values of the above character are given in Table 15.

(TABLE 15)

Maximum girth of finger (15.4 cm) was recorded by Dakshinsagar and the minimum by Nanarai (7.9 cm) with a general mean of 10.79 cm. The varietal differences were significant for girth of individual finger (Appendix-1).

Table 15. Ranking of the varieties for girth of individual finger (in cm)

Sl. No.	Name of the variety	Genomic group	Mean Value
1	Dakshinsagar	ABB	15.40
2	Kanchikela	ABB	14.93
3	Dugnan	--	14.17
4	Nendran	AAB	12.70
5	Mulanthuruthy Nendran	AAB	12.60
6	Robusta	AAA	12.40
7	Nallachakkarakeli	AAA	11.87
8	Chenganassery Nendran	AAB	11.83
9	Podalimoongil	AAB	11.80
10	Karpooravalli	ABB	11.70
11	Palayankodan	AAB	11.63
12	Valiya Kunnan	AB	11.50
13	Suwandel	AAB	11.43
14	Vamanakeli	AAA	11.31
15	Mauritius	AAA	11.07
16	Poovan Kunnan	AB	11.07
17	Kapook	ABB	11.07
18	Motta poovan	AAB	11.03
19	Kunnan	AB	11.00
20	Koothabantha	ABB	10.97
21	Virupakshi	AAB	10.83
22	Gros Michel	AAA	10.83
23	Nendravannan	AAB	10.77
24	Pisang awak	ABB	10.73
25	Adukkan	AB	10.67
26	Dwarf Cavendish	AAA	10.67

(Contd.)

Table 15. (Contd.)

Sl. No.	Name of the variety	Genomic group	Mean value
27	Lady's finger	AAB	10.47
28	Chakkarakadali	AB	10.43
29	Ney poovan	AB	10.43
30	H-135	AAB	10.30
31	Peyan	ABB	10.10
32	Ennabenian	ABB	10.06
33	Vannan	AAB	10.00
34	Karinkadali	AAB	10.00
35	Njali poovan	AB	10.00
36	Pey Kunnan	ABB	9.83
37	Nendra Kunnan	AB	9.77
38	Ambalakadali	AB	9.67
39	Pacha chingan	AAB	9.57
40	Mannan	AAB	9.57
41	Cheenabale	--	9.53
42	Manoranjitham	AAA	9.47
43	Pachanadan	AAB	9.33
44	Adakka Kunnan	AB	9.00
45	Sirumalai	AAB	8.93
46	Thaen Kunnan	AB	8.87
47	Pisang lilin	AA	8.83
48	Namarai	AA	7.90

General mean: 10.79
C.D. : 1.314

Genetic component of total variance for the character was high (Vp = 2.60, Vg = 1.97, Ve = 0.63) (Table 21) with high heritability of 75.72 per cent. The expected genetic advance as percentage of mean was 23.35 per cent (Table 23). The phenotypic and genotypic coefficients of variation were found to be 14.95 and 13.01 per cent respectively (Table 22).

Weight of individual finger (in g)

The mean values for weight of individual finger in respect of the 48 varieties studied are furnished in Table 16.

(TABLE 16)

The mean weight of individual finger ranged from 18.17 g in Namarai to 187.57 g in Dakshinsagar with a general mean of 79.52 g (Table 16). From the analysis of variance table given in Appendix-1, it can be seen that there was significant difference among the varieties for weight of individual finger.

Phenotypic and genotypic variances were very high with a high heritability and genetic gain. (Vp = 1652.35, Vg = 1430.62, Ve = 221.73) (Table 21).

Table 16. Ranking of the varieties for weight of individual finger (in g)

Sl. No.	Name of the variety	Genomic group	Mean value
1	Dakshinsagar	ABB	187.57
2	Kanchikela	ABB	163.67
3	Robusta	AAA	160.42
4	Bugnan	--	155.67
5	Mulanthuruthy Nendran	AAB	145.33
6	Chenganassery Nendran	AAB	139.68
7	Padalimoongil	AAB	126.33
8	Nendran	AAB	123.27
9	Mauritius	AAA	122.67
10	Dwarf Cavendish	AAA	121.10
11	Vamanakeli	AAA	114.33
12	Karimkadali	AAB	102.43
13	Gros Michel	AAA	92.73
14	Suwandel	AAB	91.33
15	Nallachakkarakeli	AAA	87.60
16	Valiya Kunnan	AB	85.42
17	Poloyankodan	AAB	77.67
18	Nendravarman	AAB	77.60
19	Adukkan	AB	72.47
20	Kunnan	AB	72.18
21	Kosthabontha	ABB	71.80
22	Pisang awak	ABB	71.07
23	Kapook	ABB	69.20
24	H-135	AAB	67.70
25	Peyan	ABB	66.40
26	Karpoorevalli	ABB	65.53

(Contd.)

Table 16. (Contd.)

Sl. No.	Name of the variety	Genomic group	Mean value
27	Mannan	AAB	63.13
28	Ennabenian	ABB	63.03
29	Pacha chingan	AAB	62.20
30	Virupakshi	AAB	59.27
31	Chakkarakadali	AB	59.13
32	Motta poovan	AAB	57.50
33	Ney poovan	AB	56.83
34	Pisang lilin	AA	56.67
35	Pey Kunnan	ABB	56.03
36	Theen Kunnan	AB	53.00
37	Poocha Kunnan	AB	52.27
38	Vannan	AAB	50.50
39	Ujali poovan	AB	48.87
40	Manoranjitham	AAA	46.63
41	Ambalakadali	AB	46.30
42	Nendra Kunnan	AB	45.27
43	Lady's finger	AAB	44.87
44	Cheenabale	--	43.27
45	Pachanaadan	AAB	39.00
46	Sirumalai	AAB	36.77
47	Adakka Kunnan	AB	27.00
48	Nanarai	AA	18.17

General mean : 79.52
C.D. : 21.766

Among the 18 characters studied, the highest genetic gain was for weight of individual finger. (H = 86.58%, GG = 91.17%) (Table 23). The character showed high phenotypic and genotypic coefficients of variation also. (PCV = 51.95% and GCV = 48.34%) (Table 22). The high heritability and genetic gain along with high coefficients of variation showed that selection for this character could be highly effective.

Total number of fingers per bunch

Mean values of number of fingers per bunch are presented in Table 17.

(TABLE 17)

Among the 48 varieties studied total number of fingers in a bunch ranged from 29.33 in Padalimoongil (AAB) to 224.33 in Kosthabontha (ABB) with a general mean of 123.16. The varieties showed significant difference with reference to this character (Appendix-1). Out of the total phenotypic variance of 2765.63, 2591.23 was genotypic and 174.40 environmental (Table 21).

Table 17. Ranking of the varieties for total number of fingers per bunch

Sl. No.	Name of the variety	Genomic group	Mean value
1	Kosthabontha	ABB	224.33
2	Pisang awak	ABB	224.00
3	Nellachakkarakeli	AAA	215.33
4	Njali poovan	AB	206.67
5	Motta poovan	AAB	204.67
6	Peyan	ABB	198.33
7	Kapook	ABB	196.67
8	Pey Kunnan	ABB	191.00
9	Karpooravalli	ABB	190.00
10	Palayankodan	AAB	188.67
11	Adakka Kunnan	AB	177.67
12	Ney Poovan	AB	169.33
13	Ambalakadali	AB	155.67
14	Thaen Kunnan	AB	152.00
15	Poocha Kunnan	AB	150.67
16	Mauritius	AAA	149.00
17	Kunnan	AB	147.67
18	Chakkarakadali	AB	133.00
19	Dwarf Cavendish	AAA	128.67
20	Robusta	AAA	128.33
21	Adukkan	AB	119.67
22	Pachanaadan	AAB	114.30
23	Vamanakeli	AAA	112.00
24	Kanchikela	ABB	108.33
25	Gros Michel	AAA	106.67
26	Nendra Kunnan	AB	103.00

(Contd.)

Table 17. (Contd.)

Sl. No.	Name of the variety	Genomic group	Mean value
27	Ennabenian	ABB	100.67
28	Karimkadali	AAB	100.00
29	Bugnan	--	99.00
30	Lady's finger	AAB	98.33
31	Cheenabale	--	97.67
32	Pacha chingan	AAB	97.00
33	Vannan	AAB	91.67
34	Suvendel	AAB	91.00
35	Valiya Kunnan	AB	90.67
36	Nendravannan	AAB	89.00
37	H-135	AAB	88.33
38	Mannan	AAB	87.00
39	Virupakshi	AAB	82.67
40	Dakshinsagar	ABB	77.67
41	Sirumalai	AAB	74.33
42	Pisang lilin	AA	68.00
43	Manoranjitham	AAA	67.67
44	Mulanthuruthy Nendran	AAB	55.67
45	Nendran	AAB	46.67
46	Changanassery Nendran	AAB	45.00
47	Namarai	AA	38.67
48	Padalimoongil	AAB	29.33

General mean : 123.16
C.D. : 20.314

Among the 18 characters studied, the maximum heritability was shown by total number of fingers per bunch (93.69%). The expected genetic gain was also high for this character (82.41%) (Table 23) with high phenotypic and genotypic coefficients of variation (PCV = 43.37%, GCV = 41.98%, ECV = 10.80%).

Bunch length (in cm)

Mean values for length of the bunch in respect of 48 varieties studied are presented in Table 18.

(TABLE 18)

Among the varieties studied the values ranged from 66.67 cm in Neypoovan having AB genome to 13.57 cm in the wold diploid Nemarai with a general mean of 48.55 cm. There was significant difference among varieties for bunch length (Appendix-1).

The genetic component of variation for this character was found to be high (Vp = 184.86, Vg = 159.55, Ve = 25.31) (Table 21). The heritability and expected genetic advance as percentage of mean were also high (H = 86.31% and GG = 49.78%) (Table 23). The phenotypic and genotypic coefficients of variation

Table 18. Ranking of the varieties for bunch length (in cm)

Sl. No.	Name of the variety	Genomic group	Mean value
1	Ney poovan	AB	66.67
2	Peyan	ABB	66.67
3	Njali poovan	AB	66.33
4	Pisang awak	ABB	66.27
5	Pey Kunnan	ABB	65.00
6	Robusta	AAA	64.33
7	Gros Michel	AAA	62.67
8	Nallachakkarakeli	AAA	62.33
9	Poocha Kunnan	AB	62.33
10	Kapook	ABB	62.33
11	Kosthabontha	ABB	61.33
12	Mauritius	AAA	59.67
13	Palayankodan	AAB	59.67
14	Kanchikela	ABB	59.60
15	Dwarf Cavendish	AAA	59.33
16	Motta poovan	AAB	59.00
17	Karpooravalli	ABB	58.00
18	Manoranjitham	AAA	55.00
19	Ambalakadali	AB	53.00
20	Chakkarakadali	AB	51.27
21	Vamanakeli	AAA	51.00
22	Karimkadali	AAB	49.73
23	Suwandel	AAB	48.67
24	Bugnan	--	48.33
25	Cheenabale	--	48.17
26	Mannan	AAB	48.17

(Contd.)

Table 18. (Contd.)

Sl. No.	Name of the variety	Genomic group	Mean value
27	Nendravannan	AAB	46.60
28	Thaen Kunnan	AB	46.00
29	Dakshinsagar	ABB	43.67
30	Ennabenian	ABB	43.67
31	Pacha chingan	AAB	43.37
32	Lady's finger	AAB	43.33
33	Nendra Kunnan	AB	43.33
34	Vannan	AAB	42.67
35	Adukkan	AB	42.33
36	H-135	AAB	41.50
37	Virupakshi	AAB	40.67
38	Adakka Kunnan	AB	39.67
39	Pachanaadan	AAB	39.50
40	Sirumalai	AAB	37.67
41	Milanthuruthy Nendran	AAB	36.00
42	Valiya Kunnan	AB	34.67
43	Kunnan	AB	32.67
44	Nendran	AAB	28.83
45	Pisang lilin	AA	28.00
46	Changanassery Nendran	AAB	27.67
47	Padalimoongil	AAB	19.33
48	Namarai	AA	13.57

General mean : 48.55
C.D. : 7.557

were 28.20 and 26.20 per cent respectively.

Bunch weight (in kg)

The mean values of bunch weight in respect of 48 varieties are presented in Table 19.

(TABLE 19)

The results presentedin the above table revealed that the mean weight of bunch among the 48 banana varieties ranged from 0.53 kg to 19.33 kg. The highest mean weight (19.33 kg) was recorded by three varieties viz., Robusta and Mauritius belonging to AAA genomic group and Kanchikela of the ABB genomic group. Namarai a wild diploid variety with AA genome showed the lowest mean value (0.53 kg) for bunch weight with a general mean of 10.37 kg. The analysis of variance revealed significant difference among the varieties for bunch weight (Appendix-I).

The estimated phenotypic variance (Vp) for this character was 23.76 and the same could be divided into genotypic variance (Vg) and environmental variance (Ve) as 20.7 and 3.06 respectively indicating the relatively high influence of genotype on this character (Table 21). The high phenotypic and genotypic

Table 19. Ranking of the varieties for bunch weight (in kg)

Sl. No.	Name of the variety	Genomic group	Mean value
1	Robusta	AAA	19.33
2	Mauritius	AAA	19.33
3	Kanchikela	ABB	19.33
4	Dugnan	--	18.40
5	Kapock	ABB	17.43
6	Nallachakkrakeli	AAA	17.33
7	Kosthabontha	ABB	17.17
8	Pisang awak	ABB	16.50
9	Peyan	ABB	16.33
10	Dwarf Cavendish	AAA	16.17
11	Paleyankodan	AAB	15.17
12	Karpooravalli	ABB	15.06
13	Pey Kunnan	ABB	13.83
14	Dakshinsagar	ABB	13.67
15	Vamalakeli	AAA	13.17
16	Gros Michel	AAA	13.00
17	Motta poovan	AAB	12.33
18	Kunnan	AB	11.17
19	Neypoovan	AB	10.17
20	Njali poovan	AB	10.10
21	Karinkadali	AAB	10.00
22	Adukkan	AB	9.67
23	Chakkarakadali	AB	9.60
24	Suwandel	AAB	9.33
25	Mulanthuruthy Nendran	AAB	9.17
26	Poocha Kunnan	AB	8.60

(Contd.)

Table 19 (Contd.)

Sl. No.	Name of the variety	Genomic group	Mean value
27	Thaen Kunnan	AB	8.53
28	Nendran	AAB	8.33
29	Valiya Kunnan	AB	8.33
30	Ambalekadali	AB	8.00
31	Nendravannan	AAB	7.57
32	H-135	AAB	7.33
33	Manoranjitham	AAA	7.10
34	Ennabenian	ABB	7.00
35	Pacha chingan	AAB	6.83
36	Nendra Kunnan	AB	6.73
37	Mannan	AAB	6.67
38	Adakka Kunnan	AB	6.27
39	Changanassery Nendran	AAB	6.17
40	Virupakshi	AAB	5.83
41	Padalimoongil	AAB	5.67
42	Vannan	AAB	5.67
43	Cheenabale	--	5.13
44	Pachanaadan	AAB	5.07
45	Lady's finger	AAB	4.93
46	Sirumalai	AAB	4.50
47	Pisang lilin	AA	4.00
48	Namarai	AA	0.53

General mean : 10.37
C.D. : 2.588

coefficients of variation (PCV = 48.38% and GCV = 45.17%) presented in Table 22 also confirmed the above fact. Heritability and expected genetic advance as percentage of mean were also very high (H = 87.14%, GG = 84.47%) (Table 23).

While each of the tables from 2 to 19 gives information only about one single character in respect of all the varieties, information on all the 18 characters in respect of all the 48 varieties representing the two extremes of yield potential is furnished in Table 20.

(TABLE 20)

The results presented in the above table indicated that the material selected for present study were highly variable.

Correlation between yield and selected yield components

The genotypic and phenotypic correlation coefficients between yield and 17 other characters were estimated. The data are presented in Table 24.

(TABLE 24)

Results presented in Table 24 showed that all the characters except length of individual finger,

Table 20. Range, mean and standard error of mean for the different characters

Sl. No.	Characters	Range		Mean	Standard error
		From	To		
1	Height of pseudostem at shooting time (in cm)	137.50	421.83	306.98	10.426
2	Girth at the base of pseudostem at shooting time (in cm)	27.33	88.00	66.19	2.218
3	Number of leaves per plant at shooting time	9.67	20.67	15.92	0.800
4	Total number of leaves per plant	20.00	40.33	31.82	1.005
5	Leaf area (in m^2)	0.30	2.02	1.17	0.082
6	Length of petiole (in cm)	18.50	76.87	50.90	3.002
7	Width of petiole canal (in cm)	1.00	5.00	2.74	0.096
8	Phylacron (in days)	6.41	9.19	7.75	0.243
9	Length of pedicel (in cm)	1.47	5.80	3.51	0.196
10	Duration of the crop (in days)	317.33	384.00	371.46	2.322
11	Number of hands per bunch	3.33	14.33	8.65	0.434
12	Number of fingers per hand	10.00	25.33	15.35	0.884
13	Length of individual finger (in cm)	7.90	22.50	14.62	0.898
14	Girth of individual finger (in cm)	7.90	15.40	10.79	0.473
15	Weight of individual finger (in g)	18.17	187.57	79.52	7.828
16	Total number of fingers per bunch	29.33	224.33	123.16	7.300
17	Bunch length (in cm)	13.57	66.67	48.55	2.718
18	Bunch weight (in kg)	0.53	19.33	10.37	0.924

Table 21. Phenotypic, genotypic and environmental variances for the different characters

Sl. No.	Characters	Phenotypic variance Vp	Genotypic variance Vg	Environmental variance Ve
1	Height of pseudostem at shooting time (in cm)	4184.22	3547.48	636.73
2	Girth at the base of pseudostem at shooting time (in cm)	99.27	81.16	18.11
3	Number of leaves per plant at shooting time	6.84	4.88	1.96
4	Total number of leaves per plant	14.08	11.03	3.05
5	Leaf area (in m^2)	0.09	0.07	0.03
6	Length of petiole (in cm)	173.93	115.99	57.99
7	Width of petiole canal (in cm)	1.26	1.19	0.07
8	Phylacron (in days)	0.53	0.35	0.18
9	Length of pedicel (in cm)	0.73	0.60	0.12
10	Duration of the crop (in days)	301.41	262.81	38.60
11	Number of Hands per bunch	7.78	7.14	0.64
12	Number of fingers per hand	10.76	8.61	2.15
13	Length of individual finger (in cm)	104.94	8.62	96.32
14	Girth of individual finger (in cm)	2.60	1.97	0.63
15	Weight of individual finger (in g)	1652.35	1430.62	221.73
16	Total number of fingers per bunch	2765.63	2591.23	174.40
17	Bunch length (in cm)	184.86	159.55	25.31
18	Bunch weight (in kg)	23.76	20.71	3.06

Table 22. Phenotypic, genotypic and environmental coefficients of variation for the different characters

Sl.No.	Characters	PCV	GCV	ECV
1	Height of pseudostem at shooting time (in cm)	21.00	19.34	8.19
2	Girth at the base of pseudostem at shooting time (in cm)	15.07	13.63	6.44
3	Number of leaves per plant at shooting time	16.39	13.85	8.79
4	Total number of leaves per plant	11.66	10.32	5.43
5	Leaf area (in m^2)	25.51	21.71	13.39
6	Length of petiole (in cm)	25.70	20.99	14.84
7	Width of petiole canal (in cm)	41.95	40.76	9.89
8	Phylacron (in days)	9.41	7.65	5.47
9	Length of pedicel (in cm)	24.46	22.29	10.06
10	Duration of the crop (in days)	4.67	4.36	1.67
11	Number of hands per bunch	32.54	31.18	9.35
12	Number of fingers per hand	21.64	19.36	9.68
13	Length of individual finger (in cm)	66.98	19.20	64.18
14	Girth of individual finger (in cm)	14.95	13.01	7.37
15	Weight of individual finger (in g)	51.95	48.34	19.03
16	Total number of fingers per bunch	43.37	41.98	10.80
17	Bunch length (in cm)	28.20	26.20	10.44
18	Bunch weight (in kg)	48.38	45.17	17.35

Fig.1 Phenotypic and genotypic coefficients of variation

1 Height of pseudostem at shooting time (in cm)

2 Girth at the base of pseudostem at shooting time (in cm)

3 Number of leaves per plant at shooting time

4 Total number of leaves per plant

5 Leaf area (in m^2)

6 Length of petiole (in cm)

7 Width of petiole canal (in cm)

8 Phylecron (in days)

9 Length of pedicel (in cm)

10 Duration of the crop (in days)

11 Number of hands per bunch

12 Number of fingers per hand

13 Length of individual finger (in cm)

14 Girth of individual finger (in cm)

15 Weight of individual finger (in g)

16 Total number of fingers per bunch

17 Bunch length (in cm)

18 Bunch weight (in kg)

Fig-1. PHENOTYPIC AND GENOTYPIC COEFFICIENTS OF VARIATION.

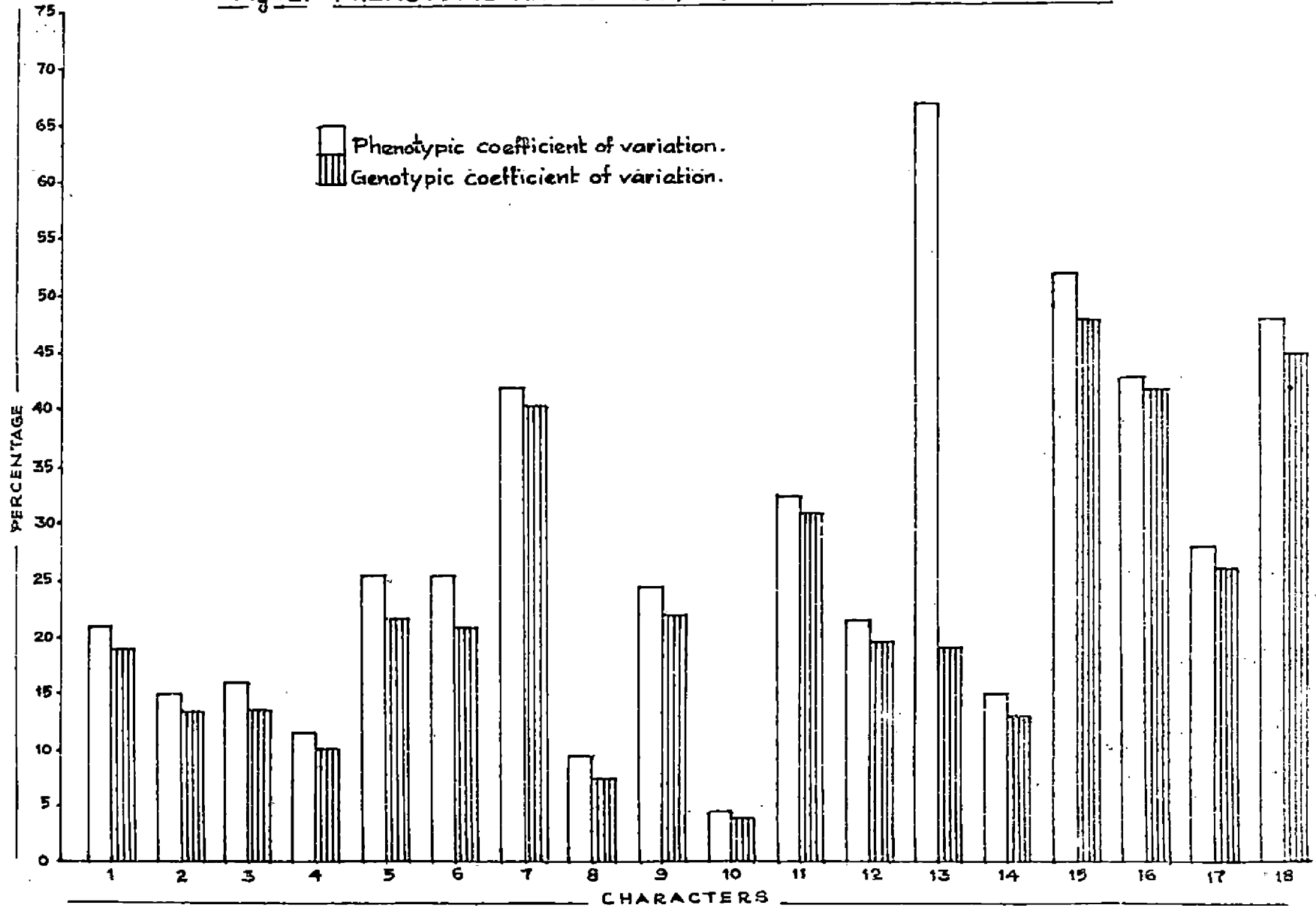


Table 23. Heritability, expected genetic advance and genetic gain for the different characters

Sl.No.	Characters	Heritability	Expected genetic advance	Expected genetic gain
1	Height of pseudostem at shooting time (in cm)	84.78	112.97	36.80
2	Girth at the base of pseudostem at shooting time (in cm)	81.76	16.79	25.37
3	Number of leaves per plant at shooting time	71.33	3.85	24.18
4	Total number of leaves per plant	78.33	6.06	19.04
5	Leaf area (in m^2)	72.44	0.45	38.46
6	Length of petiole (in cm)	66.67	18.12	35.60
7	Width of petiole canal (in cm)	91.44	2.19	79.93
8	Phylacron (in days)	66.15	1.00	12.90
9	Length of pedicel (in cm)	83.09	1.46	41.60
10	Duration of the crop (in days)	87.19	31.19	8.40
11	Number of hands per bunch	91.75	5.27	60.92
12	Number of fingers per hand	80.00	5.41	35.24
13	Length of individual finger (in cm)	8.22	1.73	11.83
14	Girth of individual finger (in cm)	75.72	2.52	23.35
15	Weight of individual finger (in g)	86.58	72.50	91.17
16	Total number of fingers per bunch	93.69	101.50	82.41
17	Bunch length (in cm)	86.31	24.17	49.78
18	Bunch weight (in kg)	87.14	8.76	84.47

Fig. 2 HERITABILITY AND GENETIC ADVANCE AS PERCENTAGE OF MEAN

1 Height of pseudostem at shooting time (in cm)
2 Girth at the base of pseudostem at shooting time (in cm)
3 Number of leaves per plant at shooting time
4 Total number of leaves per plant
5 Leaf area (in m^2)
6 Length of petiole (in cm)
7 Width of petiole canal (in cm)
8 Phyllocron (in days)
9 Length of pedicel (in cm)
10 Duration of the crop (in days)
11 Number of hands per bunch
12 Number of fingers per hand
13 Length of individual finger (in cm)
14 Girth of individual finger (in cm)
15 Weight of individual finger (in g)
16 Total number of fingers per bunch
17 Bunch length (in cm)
18 Bunch weight (in kg)

Fig-2. HERITABILITY AND EXPECTED GENETIC ADVANCE AS PERCENTAGE OF MEAN.

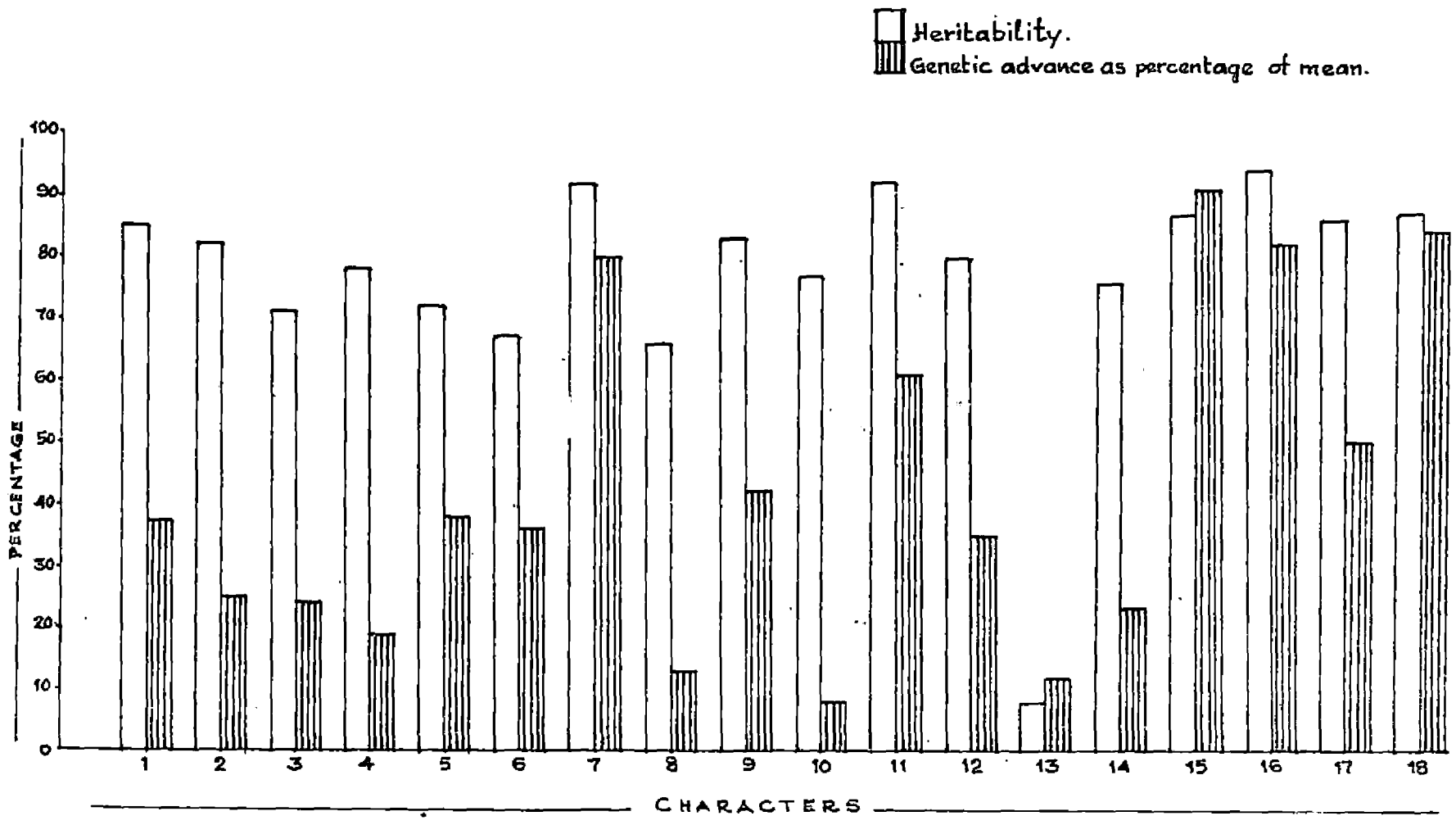


Table 24. Phenotypic, genotypic and environmental correlations between bunch weight and the other characters

Sl. No.	Characters	Phenotypic correlation	Genotypic correlation	Environmental correlation
1	Height of pseudostem at shooting time (in cm)	0.222**	0.253**	0.032
2	Girth at the base of pseudostem at shooting time (in cm)	0.579**	0.610**	0.418**
3	Number of leaves per plant at shooting time	0.366**	0.429**	0.143
4	Total number of leaves per plant	0.502**	0.587**	0.102
5	Leaf area (in m^2)	0.514**	0.614**	0.135
6	Length of petiole (in cm)	-0.006	0.037	-0.008
7	Width of petiole canal (in cm)	0.010	-0.022	0.358**
8	Phylacron (in days)	-0.274**	-0.292**	-0.250*
9	Length of pedicel (in cm)	0.275**	0.305*	0.105
10	Duration of the crop (in days)	0.229**	0.275**	-0.008
11	Number of hands per bunch	0.640**	0.649**	0.581**
12	Number of fingers per hand	0.427**	0.468**	0.222**
13	Length of individual finger (incm)	0.093	0.271**	0.059
14	Girth of individual finger (in cm)	0.564**	0.597**	0.449**
15	Weight of individual finger (in g)	0.548**	0.522**	0.716**
16	Total number of fingers per bunch	0.582**	0.588**	0.557**
17	Bunch length (in cm)	0.682**	0.713**	0.479**

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

Fig. 3 CORRELATION COEFFICIENTS BETWEEN YIELD AND THE COMPONENT CHARACTERS

x_1y - Correlation coefficients between height of pseudostem at shooting time and bunch weight.

x_2y - Correlation coefficients between girth at the base of pseudostem at shooting time and bunch weight.

x_3y - Correlation coefficients between number of leaves per plant at shooting time and bunch weight.

x_4y - Correlation coefficients between total number of leaves per plant and bunch weight.

x_5y - Correlation coefficients between leaf area and bunch weight.

x_6y - Correlation coefficients between phylacron and bunch weight.

x_7y - Correlation coefficients between length of pedicel and bunch weight.

x_8y - Correlation coefficients between duration of the crop and bunch weight.

x_9y - Correlation coefficients between number of hands per bunch and bunch weight.

$x_{10}y$ - Correlation coefficients between number of fingers per hand and bunch weight.

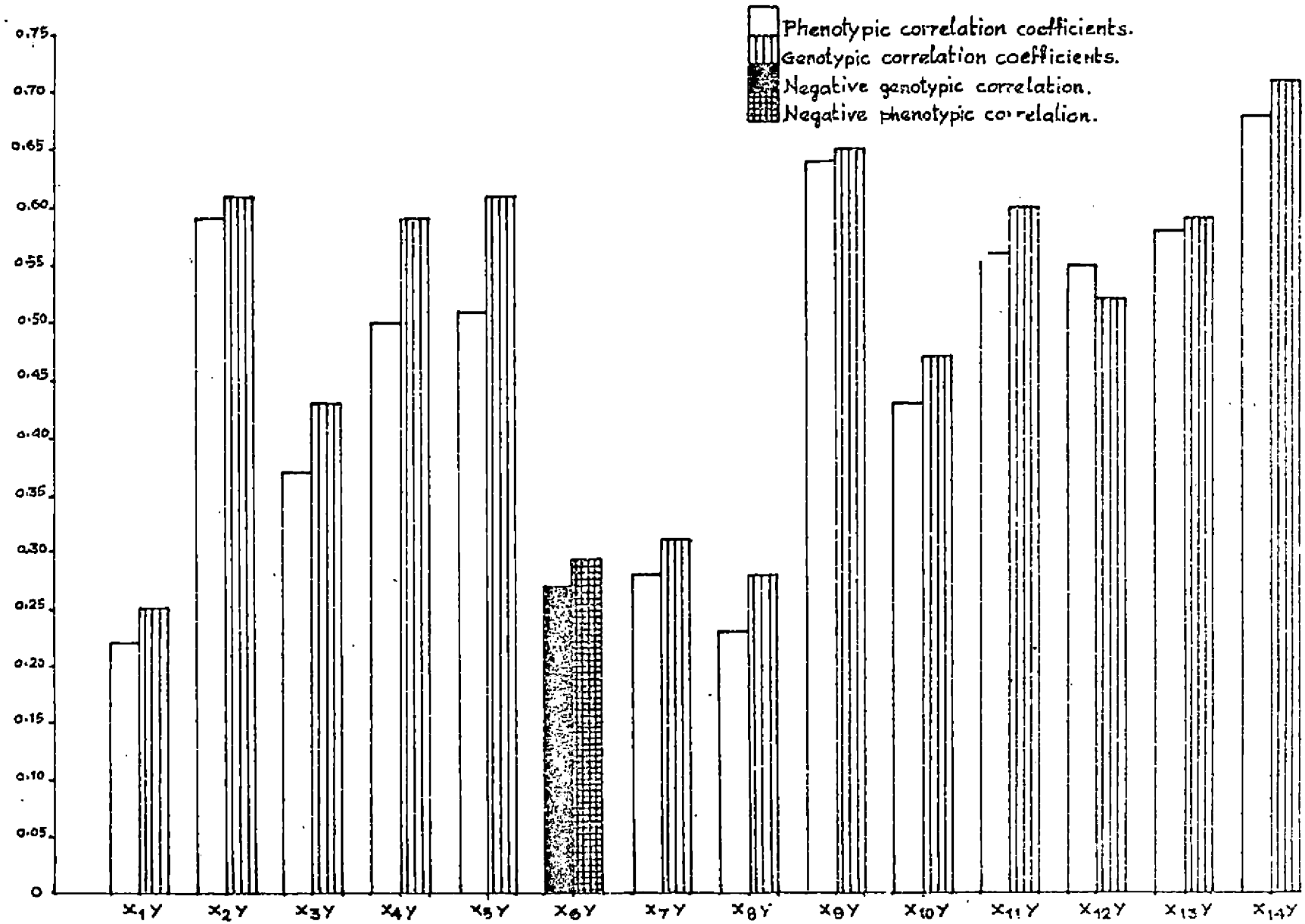
$x_{11}y$ - Correlation coefficients between girth of individual finger and bunch weight.

$x_{12}y$ - Correlation coefficients between weight of individual finger and bunch weight.

$x_{13}y$ - Correlation coefficients between total number of fingers per bunch and bunch weight

$x_{14}y$ - Correlation coefficients between bunch length and bunch weight.

Fig-3. CORRELATION COEFFICIENTS BETWEEN YIELD AND THE COMPONENT CHARACTERS.



length of petiole and width of petiole canal revealed significant positive correlation with yield. However, phylacron exhibited significant negative correlation with yield (rp = -0.274, rg = -0.292) (Table 24).

Table 25 represents the correlation coefficients among the eight selected characters.

(TABLE 25)

All the selected characters, viz., number of hands per bunch, girth of individual finger, girth at the base of pseudostem, total number of leaves per plant, leaf area, bunch length, total number of fingers per bunch and weight of individual finger showed significant correlation with yield, the maximum correlation being shown by the characters bunch length (rg = 0.7271, rp = 0.7091) number of hands per bunch (rg = 0.6641, rp = 0.6601) and number of fingers per bunch (rg = 0.592, rp = 0.596).

Number of hands per bunch showed significant positive correlation with total number of fingers per bunch (rg = 0.939, rp = 0.919) bunch length (rg = 0.818 , rp = 780) and girth of the plant (rg = 0.461, rp =0.399).

Correlation between number of hand per bunch and girth of individual finger was negative but not significant (rg = -0.021 and rp = -0.027 respectively).

Girth of individual finger had got a high correlation with weight of individual finger (rg = 0.088, rp = 0.834). The correlation of girth of individual finger with girth at the base of pseudostem and total number of leaves per plant were significant only at phenotypic level (rp = 0.315 and 0.303 respectively).

Girth at the base of pseudostem was positively and significantly correlated with total number of leaves per plant (rg = 0.741, rp = 0.644), leaf area (rg = 0.887, rp = 0.683), bunch length (rp = 0.616, rg = 0.673) and total number of fingers per bunch (rg = 0.546, rp = 0.531) both at genotypic and phenotypic levels.

Total number of leaves per plant had significant positive correlation with leaf area (rg = 0.755, rp = 0.599), bunch length (rg = 0.547, rp = 0.487) and total number of fingers per bunch (rg = 0.381, rp = 0.347) but the correlation with weight of individual

finger was significant only at phenotypic level.

Leaf area was significantly correlated with bunch length (rg = 0.681, rp = 0.600), and total number of fingers per bunch (rg = 0.631, rp = 0.522).

Bunch length showed significant correlation with total number of fingers per bunch (rg = 0.769, rp = 0.739) and total number of fingers per bunch showed a negative correlation with weight of individual finger (rg = -0.282, rp = -0.234).

Path coefficient analysis

In order to find out the direct and indirect effects of selected yield components viz., number of hands per bunch, girth of individual finger, girth at the base of pseudostem, total number of leaves per plant, leaf area, bunch length, total number of fingers per bunch and weight of individual finger on yield per plant (weight of bunch), path coefficient analysis was done. The selection of component traits for this was based on the magnitude of significant genotypic correlation coefficients.

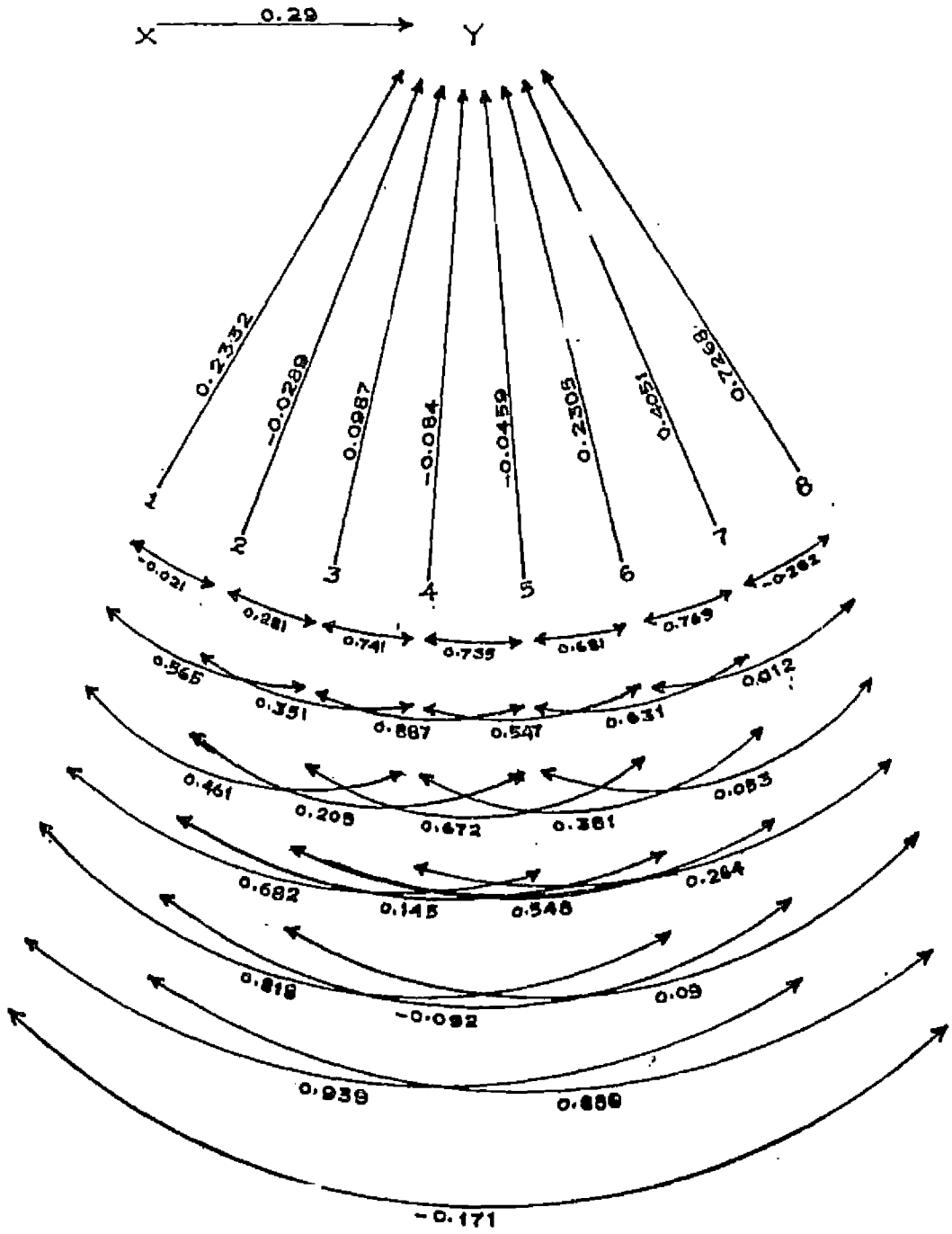
The genotypic correlations on yield per plant of its eight selected attributes were partitioned

into direct and indirect contributions of the components. Estimates of direct and indirect effects of selected characters on yield are presented in Table 26.

(TABLE 26)

The results revealed that weight of individual finger exerted the maximum direct effect (0.7268) followed by total number of fingers per bunch (0.4051) (Table 26). Eventhough the genotypic correlation coefficient was highest for length of the bunch, the maximum direct effect was shown by weight of individual finger. This can be due to the low indirect effect of other component characters through weight of individual finger. Moreover, though the direct effect of bunch length was 0.2305, its indirect effects through total number of fingers per bunch (0.3116) and number of hands per bunch (0.1908) were relatively high. Number of hands per bunch and girth at the base of pseudostem also had positive direct effects on yield (0.2332 and 0.0987). Other component characters viz., girth of individual finger, total number of leaves per plant and leaf area were having negative direct effects (-0.0289, -0.084 and -0.0459) but the values were very small.

Fig.4. PATH DIAGRAM INDICATING DIRECT AND INDIRECT EFFECTS OF THE COMPONENT CHARACTERS ON YIELD



→ Path coefficients.	⌒ r(g) Genotypic correlation.
1. Number of hands per bunch.	6. Bunch length.
2. Girth of individual finger.	7. Total number of fingers per bunch.
3. Girth at the base of pseudostem.	8. Weight of individual finger.
4. Total number of leaves per plant.	Y. Bunch weight.
5. Leaf area.	X. Residual effect.

The indirect influence of number of hands per bunch on yield through total number of fingers per bunch was high (0.3802). Total number of fingers per bunch had high direct effect and at the same time the indirect effect of other characters like bunch length and number of hands per bunch through total number of fingers per bunch were also high.

Direct effect of girth of individual finger was negative and small (-0.0289) but its contribution through weight of individual finger was very high (0.6452). Direct effect of leaf area also was negative (-0.0459) but its effect through total number of fingers per bunch, number of hands per bunch and bunch length was high (0.2557, 0.1591 and 0.1569 respectively).

The results also indicated that the eight component characters alone and in combination contributed 91.8 per cent of the variability in yield of the plant. (R^2 = 0.918).

Selection index

Three selection indices were formulated using different combinations of characters. In the first case four characters having high positive direct

effects on bunch weight viz., number of hands per bunch, bunch length, total number of fingers per bunch and weight of individual finger were considered and the following selection index was obtained.

$$I_1 = 0.346\ x_1 + 0.077\ x_2 + 0.032\ x_3 + 0.070\ x_4$$

where

I_1 = selection index$_1$
x_1 = number of hands per bunch
x_2 = bunch length
x_3 = total number of fingers per bunch
x_4 = weight of individual finger

Selection index including yield with the above four characters also was obtained as given below.

$$I_2 = 0.905\ x_1 + 0.062\ x_2 + 0.002\ x_3 - 0.003\ x_4 - 0.003\ x_5$$

where

I_2 = selection index$_2$
x_1 = bunch weight
x_2 = number of hands per bunch
x_3 = bunch length
x_4 = total number of fingers per bunch
x_5 = weight of individual finger

In the third case, all the nine characters considered for path coefficient analysis were taken into account and the following selection index was arrived at.

$$I_3 = 0.922\ x_1 + 0.032\ x_2 - 0.049\ x_3 - 0.027\ x_4 + 0.074\ x_5 + 0.236\ x_6 - 0.002\ x_7 - 0.0021\ x_8 - 0.003\ x_9$$

where

I_3 = selection index$_3$
x_1 = bunch weight
x_2 = number of hands per bunch
x_3 = girth of individual finger
x_4 = girth at the base of pseudostem
x_5 = total number of leaves per plant
x_6 = leaf area
x_7 = bunch length
x_8 = total number of fingers per bunch
x_9 = weight of individual finger

When the characters viz., number of hands per bunch, bunch length, total number of fingers per bunch and weight of individual finger alone were considered the efficiency of the index compared to direct selection

was 0.998. When yield was also included with this set of characters the efficiency was 1.062. When all the nine characters viz., bunch weight, girth of individual finger, girth at the base of pseudostem, total number of leaves per plant, leaf area, bunch length, total number of fingers per bunch and weight of individual fingers were considered, the efficiency was 1.063. These results indicate that selection through discriminant function is superior to direct selection when yield also is included in the component characters. It can be seen that the selection through discriminant function considering the characters viz., hands per bunch, bunch length, total number of fingers per bunch, weight of individual finger and bunch weight is 6.2 per cent more effective than direct selection, while selection including all the nine characters showed only 6.3 per cent more effectiveness. Selection through discriminant function considering only the four characters which had high direct effect on yield, was inferior to direct selection. From the above results it can be seen that index 2 is the most suitable one.

Constellation of 48 banana varieties through metroglyphs.

The 48 genotypes were pictorally represented through metroglyphs (vide Fig.5).

Fig. 5 CONSTELLATION OF 48 BANANA GENOTYPES BASED ON YIELD AND ITS COMPONENTS THROUGH METROGLYPHS

	Name of variety	Genomic group
1	Ambalakadali	AB
2	Chekkara Kadali	AB
3	Karim Kadali	AAB
4	Pacha Chingan	AAB
5	Namarai	AA
6	Pisang lilin	AA
7	Adukkan	AB
8	Ney Poovan	AB
9	Njali Poovan	AB
10	Kunnan	AB
11	Vamanakeli	AAA
12	Robusta	AAA
13	DwarfxCavendish Mauritius	AAA
14	Dwarf Cavendish	AAA
15	Nallachakkarakeli	AAA
16	Gros Michel	AAA
17	Manoranjitham	AAA
18	H-135	AAB
19	Padalimoongil	AAB
20	Palayankodan	AAB
21	Mannan	AAB
22	Vannan	AAB
23	Nendra Vannan	AAB
24	Pachanaadan	AAB
25	Sirumalai	AAB
26	Virupakshi	AAB
27	Mottapoovan	AAB
28	Suwandel	AAB
29	Lady's finger	AAB
30	Adakka Kunnan	AB
31	Poocha Kunnan	AB
32	Valiyakunnan	AB
33	Nendrakunnan	AB
34	Thaenkunnan	AB
35	Nendran	AAB
36	Mulanthuruthy Nendran	AAB
37	Chenganessery Nendran	AAB
38	Dakshin Sagar	ABB
39	Cheenabale	—
40	Bugnan	—
41	Kanchikela	ABB
42	Peykunnan	ABB
43	Pisang awak	ABB
44	Peyan	ABB
45	Karpooravalli	ABB
46	Enna benian	ABB
47	Kapook	ABB
48	Kosthabontha	ABB

Discussion

DISCUSSION

Results of observations on eighteen economic characters recorded from all the plants belonging to 48 banana varieties have been analysed and presented in the previous chapter. It now remains to discuss the results as a whole so as to draw reliable and valid conclusions.

The very objective of any breeding programme is to develop crop varieties through genetic upgrading of the same. This is generally done by following different path ways which, however, are expected to give the same end result. The crop varieties thus evolved are expected to have a superior genetic make up within a morphological frame work that will result in a better and an efficient absorption of plant food ingredients from the soil and also in the harvest of solar energy resulting in better and efficient conversion of the above factors into final yield.

As a prerequisite to any breeding programme, a knowledge about the extent of variability present in the germplasm of the crop concerned is very vital for the breeder. Informations on heritability and

estimates of genetic advance that could be obtained in the next cycle of selection are also important to the breeder in deciding the appropriate method of breeding. A knowledge on the degree of association among different quantitative traits would help the breeder to pin point a character or characters whose selection would automatically bring about an overall progress of such other characters which are positively related with yield and would also result in the elimination of such others which are negatively associated with yield. Hence a thorough understanding of the genetic diversity in the crop is a must for the breeder. The investigations reported herein, essentially deal with obtaining the relevant genetic informations as a pre-requisite to any breeding programme in a number of selected banana varieties which are adapted for vegetative propogation.

Banana, essentially a fruit crop of the tropics, belongs to the genus Musa in the family Musaceae which is a member of the order Scitamineae. It is mainly cultivated for its edible fruit. Most of the cultivated types are triploids and diploids. A great majority of edible bananas are believed to have

their origin in only two wild species Musa acuminata and Musa balbisiana according to Kurz (1865), Cheesman (1948), Simmonds (1962). Because of its adaptability for vegetative propogation, multiplication and maintenance of purity of a superior genotype are easy for the breeder with reference to this crop.

The forty eight banana varieties included in the present investigation were found to be significantly different for the eighteen economic characters studied viz., height of pseudostem at shooting time, girth at the base of pseudostem at shooting time, number of leaves per plant at shooting time, total number of leaves per plant, leaf area, length of petiole, width of petiole canal, phylacron, length of pedicel, duration of the crop, number of hands per bunch, number of fingers per hand, length of individual finger, girth of individual finger, weight of individual finger, total number of fingers per bunch, bunch length and bunch weight.

Range and variation around the mean are the basic ones of the various estimates of quantitative variability. Success in genetic improvement of any crop would largely depend upon a wide genetic base resulting in a wider genetic variability. In the present

investigation, it may be seen that the range of variation for almost all characters is large particularly in respect of height of pseudostem at shooting time, girth at the base of pseudostem at shooting time, leaf area, width of petiole canal, number of hands per bunch, weight of individual finger, total number of fingers per bunch, bunch weight etc. This indicated the presence of enough variability in the population under study. Nayar et al. (1978) and (1980) have reported similar findings in case of dessert and culinary varieties of banana.

More than the observed variation, a knowledge of the extent and nature of genetic variability is all the more important for the breeder. This necessitates the breeder to partition the total variability into heritable or genetic and nonheritable or environmental components, because of the high influence of environment on the expression of quantitative traits. Estimates of variance in the present study have shown that the total observed variances in seventeen out of eighteen characters studied are mainly due to genetic causes as indicated by a higher magnitude of genotypic variance over environmental variance. Only in the case of length of individual finger, environmental

variance is seen to exceed genotypic variance, thereby indicating that this is a character, the expression of which is highly influenced by fluctuating environments. This is in conformity with the findings of Nayar et al. (1978) in the case of dessert type bananas.

More than variance it is the coefficient of variations that is more useful in cases when characters having different units of measurement are to be compared. High genotypic coefficient of variation indicates that genotypic variability present in the crop is high and enables one to compare with that present in other characters. The values estimated for phenotypic and genotypic coefficients of variation in the present investigation have revealed that width of petiole canal, weight of individual finger, total number of fingers per bunch and bunch weight have very high estimates (over 40%), thereby suggesting that there is high degree of variability in the varieties for these characters and hence the same can be utilised for crop improvement programmes (Fig.1). Characters like leaf area, length of petiole, length of pedicel, number of hands per bunch and bunch length also have moderately high estimate (20 to 40%). Characters likeheight of pseudostem at shooting time, girth at the base of

pseudostem at shooting time, total number of leaves per plant, number of fingers per hand, length of individual finger, girth of individual finger etc.are observed to have moderate genotypic coefficient of variation (10 to 20%), while phylacron and duration of the crop have exhibited low values of genotypic coefficient of variation (below 10%), thereby suggesting that these characters offer little scope for selection.

According to Gandhi et al. (1964) the magnitude of genotypic coefficient of variation alone will not help the breeder to determine the amount of variation that is heritable. Heritability estimates alone will give an index of that portion of variation that will be transmissible to the progeny. According to Burton (1952), genotypic coefficient of variation together with heritability estimates would give a true picture of the amount of progress to be expected by selection. Results of the present study have indicated that characters like width of petiole canal, number of hands per bunch and total number of fingers per bunch have exhibited high genotypic coefficient of variation coupled with high heritability estimates. Heritability estimates are the highest for total number of fingers per bunch (93.69%) followed by number of hands per bunch (91.75%) and width

of the petiole canal (91.44%). Other characters viz., height of pseudostem at shooting time, girth at the base of pseudostem at shooting time, length of pedicel, duration of the crop, number of fingers per hand, weight of individual finger, bunch length and bunch weight have given values of heritability exceeding 80 per cent. Hence these characters can be improved by selection since high heritability indicates the effectiveness with which selection of genotypes can be based on phenotypic performance (Johnson et al., 1955). Among the other traits, length of individual finger has exhibited lowest estimate of heritability of 8.22 per cent, thereby indicating the limited scope for selection for this trait.

According to Johnson et al. (1955) heritability estimates alone will not give an indication of the amount of genetic progress that would result from selecting the best individuals. Alternatively a better and more realistic approach in such a situation would be to consider heritability estimates and genetic advance jointly, so as to arrive at a more reliable conclusion. In the present study genetic advance was estimated in absolute values for each character and also as percentage of the mean (genetic gain) for comparing different characters. Expected genetic advance estimated in

absolute values for the different characters has indicated that under five per cent intensity of selection i.e. by selecting five per cent superior plants from the available population it will be possible to improve the height of pseudostem at shooting time by 16.79 cm, number of leaves per plant at shooting time by 3.85, total number of leaves per plant by 6.06, leaf area by 0.45 m^2, length of petiole by 18.12 cm, width of petiole canal by 2.19 cm, phylacron by 1.00 day, length of pedicel by 1.46 cm, duration of the crop by 31.19 days, number of hands per bunch by 5.27, number of fingers per hand by 5.41, length of individual finger by 1.73 cm, girth of individual finger by 2.52 cm, weight of individual finger 72.50 g, total number of fingers per bunch by 101.50, bunch length by 24.17 cm and bunch weight by 8.76 kg respectively.

The genetic gain estimate is seen to be maximum for weight of individual finger (91.17%) followed by bunch weight (84.47%), total number of fingers per bunch (82.41%) and width of petiole canal (79.93%). The same is seen to be minimum for duration of the crop (8.40%). The rest of the characters studied, are observed to possess values of genetic gain in between the two extremes.

According to Panse (1957) high heritability coupled with high genetic gain indicates additive gene

effects while high heritability with low genetic gain indicates nonadditive gene effects which include dominance and epistasis. Results of the present study have indicated that characters like width of the petiole canal, number of hands per bunch, weight of individual finger, total number of fingers per bunch, bunch length and bunch weight exhibit high heritability (over 86%) coupled with high or moderately high (over 50%) genetic gain estimates thereby indicating the involvement of additive gene effects for the above traits and consequently such characters can be improved through straight selection (Fig.2). Characters like girth at the base of pseudostem at shooting time, number of leaves per plant at shooting time, total number of leaves per plant, duration of the crop, girth of individual finger etc. are found to possess high heritability estimates (over 71%) coupled with low genetic gain values (less than 25%), which may be attributed to the action of nonadditive genes of the type dominance and epistasis. As such, selection has very limited scope for improving these traits.

A comparison of the available material with reference to the expression of eighteen different economic traits in relation to their genomic constitution as well

as their utility, reveals interesting results. The forty eight banana varieties included in the present study are found to fall into five genomic groups viz., AA with a frequency of 2, AB-11, AAA-7, AAB-17, ABB-9 and unknown genomic constitution-2. In the expression of 18 economic characters, triploids - AAA in three, AAB in two and ABB in nine -- are seen to have the highest values in 14 cases. The remaining four are found to be topped by diploids with AA in one case and AB in another three cases. In the expression of minimum values for the 18 characters, diploids are found to occupy 14, with AB in one and AA in thirteen cases and the remaining four being occupied by triploids, all with ABB genome. Hence, from the results of the present investigation, there seems to be no association between the strength of character expression in a variety and its genomic constitution or ploidy level.

Bananas are generally cultivated for its edible fruits used for culinary and dessert purposes. Most of the banana varieties yield tasty fruits for dessert purpose, though a few are grown for culinary needs also. However, there are also varieties which can be considered as equally good for both the purposes. Hence division of a banana germplasm based on its utility can only be arbitrary and not absolute. However, the forty eight

varieties included in the present investigation can be broadly divided into twenty culinary and twenty eight dessert types. Results of the present study have not indicated any relationship between the strength of character expression in a variety and its utility. Thus in general, it can be concluded that there is no relationship between the extent of variability and its genomic constitution and ploidy level on the one hand and its utility on the other.

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. A more rational approach for improving yield would, therefore, be a consideration of the association between different yield components and yield. A knowledge of such relationship is essential if selection for the simultaneous improvement of yield components and in turn yield has to be effective. Robinson et al. (1951) have pointed out the usefulness of genotypic and phenotypic correlations in crop improvement programmes. Genotypic correlation coefficients provide a measure of the degree of genotypic association between the characters and

indicate such of those useful for consideration. With this in view, genotypic and phenotypic correlation coefficients between bunch weight and other seventeen characters were worked out.

The results have indicated that in thirteen out of seventeen cases there has been significant positive correlation between the character and bunch weight both in the phenotypic and genotypic levels (Fig.3). In the case of phylacron the results have indicated significant negative association with yield. Within the limits of acceptable error the phenotypic and genotypic correlation coefficients of the seventeen traits with bunch weight seem to be of comparable magnitudes. However, the genotypic correlation coefficients are slightly higher than the corresponding phenotypic correlation coefficients, thereby indicating the preponderance of inherent relationship.

A simple correlation study seems to be inadequate to measure the association, since different genotypes are susceptible to environments in varying degrees. Results of correlation studies involving eight selected components and yield have indicated that in most of the cases, significant associations have been established. In General,

the genotypic correlation coefficients agree with its corresponding phenotypic correlation coefficients in magnitude. However, genotypic correlation coefficients are seen to be more than corresponding phenotypic correlation coefficients. This indicates the inherent genetic correlation of that character with yield. Correlation studies in the present investigation have also revealed that bunch weight is highly associated with bunch length, number of hands per bunch, 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, their association being significant at one per cent level as evidenced by the significance of both phenotypic and genotypic correlation coefficients. Thus all the eight components have exhibited significant association with yield. However, association of yield with its components alone is not adequate in any selection programme. A knowledge of their inter-relationship is also needed, since improvement in one component might or might not result in the improvement of other components. The estimates of inter correlations for the selected yield components in the present investigation have revealed that 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, thereby indicating that improvement through selection in one trait will take care of simultaneous improvement in the other traits as well. Total number of fingers per bunch is seen to have significant negative association with weight of individual finger. This suggests that improvement through selection of number of fingers per bunch is possible only at the expense of weight of individual finger.

This association analysis through correlation studies alone will not provide a true picture of the relative merrits or demerrits of each of the components 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. Path coefficient analysis developed by Wright (1921) and applied for the first time in plants by Duvey and Lu (1959) furnished a means for finding out the direct and indirect effects of individual components to final yield. Results of path coefficient analysis in the present investigation 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) (Fig.4). The indirect effects of the three components having negative direct effects, through these traits are also seen to be positive and fairly high in a good number of cases. Hence it is to be understood that these five components viz., weight of individual finger, total number of fingers per bunch, number of hands per bunch, bunch length and girth at the base of pseudostem at shooting time are important characters contributing to yield in banana.

The results of the present investigation have also shown that the direct effects on bunch weight of the traits viz., girth of individual finger (-0.9289), total number of leaves per plant (-0.0840) and leaf area (-0.9459) are negative, although they have contributed high significant genotypic correlation coefficients with bunch weight. This is explainable by considering the positive indirect effects of these traits through other characters. Thus for example, girth of individual finger has been observed to have 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 has been seen to have 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 same holds good in the case of leaf area also which has revealed positive indirect effects on bunch weight through total number of fingers per bunch (0.2557), number of hands per bunch (0.1591), bunch length (0.1569), 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 the eight component traits considered for the path analysis. This comparatively low value obtained in the present case adequately supports the right choice of components in banana for path coefficient analysis. Hence from the results of the present study it is to be concluded

that greater emphasis has to be laid for improving weight of individual finger, total number of fingers per bunch, number of hands per bunch, bunch length and girth at the base of pseudostem at shooting time, which have exerted positive and high direct effects towards yield.

With a view to evolving a selection index for isolating superior types, three selection indices were formulated using different combinations of characters. A comparison of the efficiency of the three indices thus formulated, 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 index.

Summary

SUMMARY

Biometrical studies in banana were undertaken at the Banana Research Station, Kannara and in the Department of Agricultural Botany, College of Horticulture, Vellanikkara during the period 1981-1982. Forty eight banana varieties of diversified origin belonging to five different genomic groups were raised in a randomised block design with three replications. Observations on eighteen economic characters were recorded from all the plants in the three replications. The data were subjected to suitable statistical analyses for estimating the variability available in the material, for working out the heritable portion of the variability and for finding out the degree of association of the different components of yield with yield either directly or indirectly.

The important findings are summaried below.

1. The 48 banana varieties showed significant differences with reference to the eighteen characters studied.

2. Estimates of phenotypic, genotypic and environmental variances have shown that a large portion

of variability in all the characters except length of individual finger was due to genetic factors. Values of phenotypic and genotypic coefficients of variation have confirmed the above conclusion.

3. Heritability estimates in the broad sense was high (over 80%) for eleven characters and moderately high (65-80%) for all the other characters except length of individual finger which showed the lowest heritability of 8.22 per cent.

4. Genetic advance estimated in absolute values was promising for all characters.

5. Genetic gain was the highest for weight of individual finger (91.17%). Other characters like width of petiole canal, number of hands per bunch, total number of fingers per bunch, bunch length and bunch weight also showed high values (above 50%) for genetic gain. Lowest genetic gain was for duration of the crop.

6. Characters like width of petiole canal, number of hands per bunch, weight of individual finger, total number of fingers per bunch, bunch length and bunch weight exhibited high heritability (over 86%) coupled with higher or moderately high (over 50%) genetic

gain estimates indicating the involvement of additive gene action for these characters. Hence these characters can be improved through straight selection.

Girth at the base of pseudostem at shooting time, number of leaves per plant at shooting time, total number of leaves per plant, duration of the crop and girth of individual finger were found to possess high heritability estimates (over 71%) coupled with low genetic gain values (less than 25%) which might be attributed to the action of nonadditive genes of the type dominance and epistasis. Hence straight selection has limited scope for improving these traits.

7. There was strong correlation between bunch weight and all the other characters studied except length of petiole, width of petiole canal and length of pedicel both at phenotypic and genotypic levels. Phylacron showed significant negative correlation with yield.

8. Inter correlations studies have shown that characters exhibiting significant association with yield were also highly inter correlated. Hence the component characters along with yield can be simultaneously improved.

9. Results of path coefficient analysis have revealed that weight of individual finger exhibited maximum direct effect. Other characters having positive direct effect with bunch weight were total number of fingers per bunch, number of hands per bunch, bunch length and girth at the base of pseudostem at shooting time. The other three characters viz., girth of individual finger, total number of leaves per plant and leaf area which showed negative direct effects, contributed towards yield mainly through other characters.

10. The residual effect was 0.082 indicating that about 92 per cent of the variation in yield were contributed by the eight component characters considered in path coefficient analysis.

11. A comparison of different indices of selection obtained by using different combinations of characters revealed that selection index formulated using the characters viz., bunch weight, number of hands per bunch, bunch length, total number of fingers per bunch and weight of individual finger was the most effective one.

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*Originals not seen

Appendices

APPENDIX - 1. ABSTRACT OF ANOVA

Source	DF	MEAN SQUARES								
		Height of pseudostem at shooting time (in cm)	Girth at the base of pseudostem at shooting time(in cm)	Number of leaves per plant at shooting time	Total number of leaves per plant	Leaf area (in m^2)	Length of petiole (in cm)	Width of petiole canal (in cm)	Phylacron (in days)	Length of pedicel (in cm)
Varieties	47	12657.21**	260.97**	17.06**	35.63**	0.23**	427.74**	3.88**	1.22**	1.98**
Replication	2	617.58	30.66	2.96	0.22	0.05	23.81	0.03	0.09	0.007
Error	94	326.11	14.76	1.92	3.03	0.02	27.04	0.03	0.18	0.12

Source	DF	Duration of the crop(in days)	Number of hands per bunch	Number of fingers per hand	Length of individual finger (in cm)	Girth of individual finger (in cm)	Weight of individual finger (in g)	Total number of fingers per bunch	Bunch length (in cm)	Bunch weight (in kg)
Varieties	47	835.23**	22.65**	34.68**	45.18**	6.59**	4627.65**	8312.24**	517.46**	70.31**
Replication	2	55.03	0.36	2.09	3.68	0.92	109.51	324.02	28.86	0.49
Error	94	16.17	0.57	2.35	2.42	0.67	183.85	160.15	22.16	2.56

** Significant at 1 per cent level

BIOMETRICAL STUDIES IN BANANA

By

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ABSTRACT OF THE THESIS

Submitted in partial fulfilment of the
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ABSTRACT

Studies were undertaken with forty eight banana varieties belonging to five different genomic groups at the Banana Research Station, Kannara and Department of Agricultural Botany, College of Horticulture, Vellanikkara during 1981-'82 to estimate the extent of genetic variability, association among the selected characters and its partition into direct and indirect effects through path coefficient analysis. Selection indices were worked out to estimate the efficiency of selection through discriminant function over straight selection or vice versa.

The results have shown that the difference between varieties were highly significant for all the eighteen characters studied.

The estimates of variance components and coefficients of variation have indicated that the major portion of total variability in all characters, except length of individual finger was due to genetic causes. Heritability in the broad sense was found to be quite high for all characters except length of individual finger. Expected genetic advance has shown that, by selecting five per cent superior plants from the population, yield could be increased by 8.76 kg per plant.

Characters such as width of petiole canal, number of hands per bunch, weight of individual finger, total number

of fingers per bunch, bunch length and bunch weight which exhibited high estimates of heritability along with high values of genetic gain might be due to the action of additive genes and could be improved straight away through selection.

Bunch weight was highly correlated with girth at the base of pseudostem, total number of leaves per plant, leaf area, number of hands per bunch, girth of individual finger, total number of fingers per bunch and bunch length. The correlation coefficients among the yield components were also highly significant.

Path coefficient analysis has shown that weight of individual finger, total number of finger per bunch, bunch length and number of hands per bunch had high direct positive effects on yield per plant. Girth of individual finger, total number of leaves per plant and leaf area exhibited low and negative direct effects on yield per plant.

Comparison of the efficiency of different selection indices showed a higher efficiency for the index obtained when characters viz., bunch weight, number of hands per bunch, bunch length, number of fingers per bunch and weight of individual finger were taken into consideration.