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STATISTICAL ANALYSIS OF THE INFLUENCE OF BIOMETRIC CHARACTERS ON YIELD IN SOME CULINARY VARIETIES OF BANANA*

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The genetical as well as the environmental factors influence the yield of any crop. So it is always of interest to analyse the effect of different morphological characters and the relationship among them in producing better results or the maximum crop yield. With regard to banana plants such works are rarely done, whereas a lot of literature is available on many other crops. For example, Dewy and Lu (1959) give a study of the influence of different characters on wheat grass production. Srivasthava and Das (1973) in another study explain the use of genetic correlation and discriminant function to brassica components. The investigations made under the present study are (1) to find the phenotypic, genotypic and environmental correlation and perform the path coefficient analysis on thirty culinary varieties using twelve different morphological characters (2) to construct a discriminant function and compare the genetic advance thus calculated with that of straight selection (3) try to evaluate a proper method of selection based on the path analysis for various biometric characters.

Materials and Methods

The morphological characters for which measurements were taken in the study were (1) height of the plant (ii) girth (iii) number of leaves (iv) weight of hands (v) weight of fingers (vi) number of fingers vii) length of fingers (viii) thickness of fingers (ix) number of hands (x) number of fingers per hand (xi) length of peduncle (xii) number of roots and weight of bunches (yield) of a plant. Thirty different varieties of the culinary type were grown in a replicated randomised block design with three replications at the Banana Research Station, Kannara of the Kerala Agricultural University for the study.

The analysis of variance tables will reveal whether there is any significant difference between the varieties or not, in respect of the characters. The general size of the characters is affected by both genetic and environmental reasons (Wright, 1968). So a detailed study of the phenotypic, genotypic and environmental correlations were made from the covariance tables. The correlations were computed as explained by Falconer (1960).

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Assuming the characters as a system of linearly related variables (forces) on their resultant (the yield) the path coefficient of the paths between the forces can be measured. The correlation between the yield and a characters is partitioned into significant components, and the path coefficients between the characters are computed. The effect of residuls (R) is computed as $1-\sum P_i r_{iy}$ where P_i are the path coefficient and r_{iy} is the genetic correlation between the ith character and y, the yield. The analysis and interpretations are according to the lines of Li (1956).

To test whether a plant belongs to a low yielding or a high yielding group (discrimination of a good genotype) is the problem considered in the construction of discriminant function As the relative importance of the characters is unknown the function is calculated by giving equal weight to the characters. A linear function $\sum b_i x_i$ is being fitted, where bi is the weight corresponding to xi the ith character. Smith's (1936) method is the maximisation of r (H, I) the correlation between the genetic worth and phenotypic performance of the characters. Th3 genetic advance and genetic gain also can b3 calculated by making us3 of discriminant function, and the percent gain in efficiency compared to straight selection also worked out. The methods explained by Fisher (1935) and Singh and Chaudhary (1977) are adopted in the calculation of efficiencies.

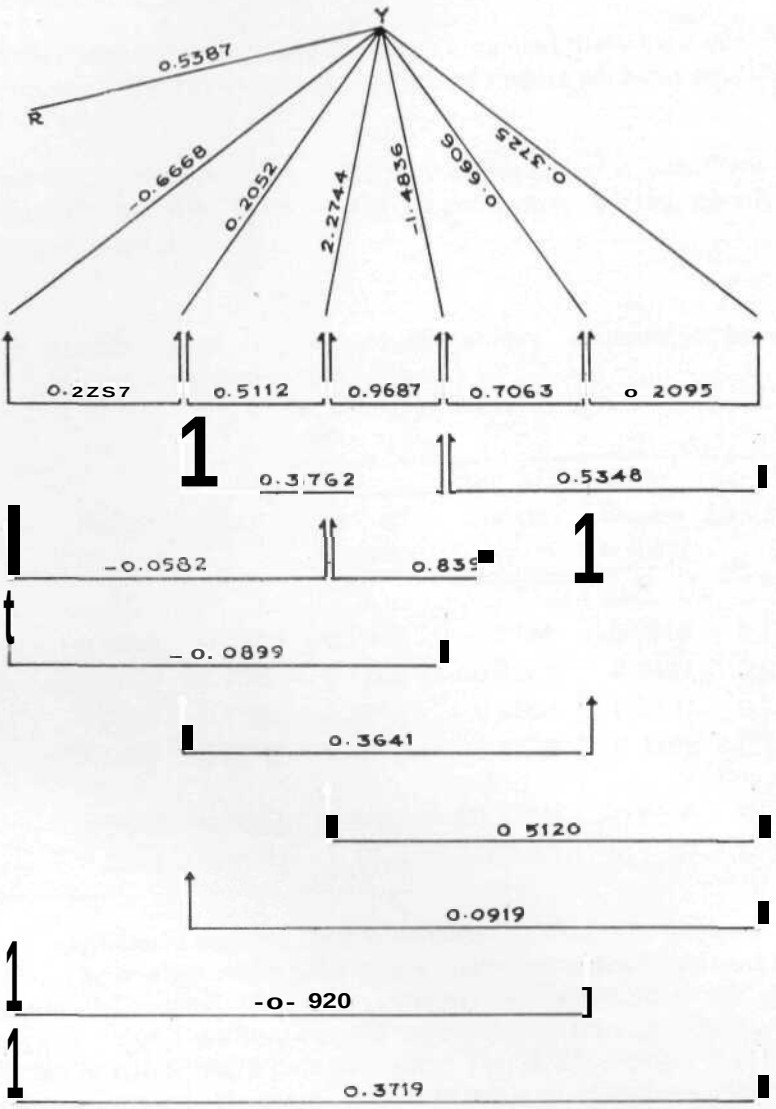
The discriminant function is used for obtaining a selection index for each of the thirty varieties as suggested by Singh and Chaudhury (1977). The index score of the ith variety $V_i = \sum X_{ij} b_j$ where x_{ij} taken here is the arithmetic mean of the observations corresponding to the jth character of the ith variety, and by the coefficient in discriminant function.

The restricted selection index is tried as suggested by Kemptherone and Nordskog (1959) by studying the changes of Y out of V characters by keeping constant, the remaining $(n-r)$ characters. The method in this case is same as before but subject to the condition that the genetic gain of the restricted chacter is zero. The behaviour of character for restricted selection can be studied by the path coefficient analysis and also by correlation studies of different characters. The formula to obtain selection indices is $b = I_{nxn} - P^{-1} GC (C'GP^{-1} GC)^{-1} C'G) P^{-1} Ga$ where I_{nxn} is the nxn identify matrix, P phenotypic and G genotypic dispersion matrix and 'a' is the vector of weightage of economic characters (here it is taken as a row vector of elements unity).

Results and Discussion

The analysis of variance of the characters showed high significant difference among the thirty varieties. It was found that the environmental correlations were less than the phenotypic and genotypic correlations in many combinations. The phenotypic and genotypic correlations of all the characters with yield were positive except the 'length of fingers'. The numbers of leaves

Fig. 1. CAUSE AND EFFECT RELATIONSHIP OF YIELD WITH OTHER CHARACTERS



CHARACTERS: 1, HEIGHT. 2. GIRTH,
3. NUMBER OF FINGERS. 4 NUMBER OF HANDS.
5. NUMBER OF FINGER PER HAND.
6. LENGTH OF PEDUNCLE AND R - RESIDUAL(h)

(—0.1104) and number of fingers per hand (—0.1236) had shown negative environmental correlation with yieid.

The heritability of the values (in broad sense) indicated that characters tike height, weight of fingers. thickness of fingers, number of fingers per hand and yield per plant were highly heritable.

From the correlation matrix of the varieties, the characters selected for the path coefficient analysis on the basis of the significance of the genotypic correlations are given in Table 1.

Table I

Path coefficients of selected yield components in culinary varieties of banana (direct and indirect effects)

Characters	Effects via					
	Height	Girth	No. of fingers	No. of hands	No. of fingers per hand	Length of peduncle
	x_1	x_2	x_3	x_4	x_5	x_6
Height	-0.0668	0.0469	-0.2045	0.1334	—0.3413	0.1385
Girth	—0.0153	0.2052	1.1763	—0.5581	0.2427	0.0342
Number of fingers	0.0039	0.1061	2.2744	—0.4363	0.5597	0.1907
Number of hands	0.0060	0.0772	2.2018	—1,4836	0.4708	0.1992
Number of fingers per hand	0.0342	0.0747	1.9096	-1.0479	—0.6606	0.0780
Length of peduncle	—0.0248	0.0189	1.1645	-0.7934	0.1397	0.3725

The path coefficients and inter-relationship between characters are represented in Fig.1. The relative importance of the characters can be assessed from it. It can be seen that the number of fingers is having the maximum direct effect (2.2744) towards yield. But if we consider the indirect effect through the number of fingers, the number of hands had a retarding effect (—1.4363). Also, the direct effect of the number of hands is negative (—1.4836) and it had the maximum positive effect through the numbers of fingers. Thus in order to get maximum yield, the number of fingers must be maximum.

The number of fingers per hand is having a negative direct effect (—0.6606) on yield. But the indirect effect through the total number of fingers is positive. (1.9096) and the indirect effect through the number of hands is negative (—1.0479). Hence it can be interpreted as the yield increases, the

number of fingers is on the increase compared to the number of hands. It is also interesting to note that the plant height had not much effect on yield the direct effect being (—0.0668) only.

Using the seven selected characters viz. height (x_1), girth (x_2), number of fingers (x_3), number of hands (x_4), number of fingers per hand (x_5), length of peduncle (x_6), and yield (x_7), the selection index and discriminant functions were constructed. The fitted discriminant function was,

$$z = -0.8369x_1 + 3.8736x_2 + 2.3405x_3 - 23.0606x_4 - 11.3156x_5 + 2.8362x_6 - 6.8963x_7$$

The genetic advance through discriminant function for 5% intensity of selection was 164.58, In order to assess its superiority over direct selection the genetic advance through straight selection was also worked out and came out to be 179.78. Thus the straight selection showed a slight superiority over the selection through discriminant function. This indicates the inadequacy of the characters included for the calculation of the selection index. The selection indices for the thirty varieties estimated by the discriminant function is given in Table 2. The best varieties were the ones with maximum score.

In the path coefficient analysis of the varieties the number of hands had a negative direct effect whereas the total correlation is positive. The direct effect caused by height is practically zero. The other characters to a great extent explain the total correlation by direct effect itseff. However, restricted selection was applied to girth (x_2) which had a direct effect, one third of the total correlation. The fitted index was

$$Z = -0.4627x_1 - 0.0740x_2 + 0.1649x_3 + 5.4240x_4 - 0.8051x_5 + 2.9406x_6 - 0.9918x_7$$

where $x_1, x_2 \ldots x_7$, were the characters included in the discriminant function analysis. The genetic advance for the above seven characters in the restricted selection case is given in Table 3,

Obviously, there is no gain in genetic advance for x_2, (girth) the character for which restriction was applied.

Summary

The plants were grown on a three replicated RBD with thirty culinary varieties of banana at the Banana Research Station (KAU) Kannara. Measurements on thirteen morphological characters were taken for the study. These biometric characters had shown high significant difference among the varieties. All the

Table 2

X'arieties and index scores

Sl. No	Varieties	Index values
1	Poykunnan	369.85
2	Wolha	292.75
3	Pisangawak	257.62
4	Nallabaksha	220.45
5	Ashybathessa	160.36
6	Jewa	153.09
7	Boodi	147.40
8	Hylenid Sawai	120.08
9	Sambrani Monthan	109.56
10	Gunabanian	104.75
11	Vannan	103.13
12	Eainsa	100.77
13	Ashmothan	98.79
14	Ceuria	92.54
15	Nanguneri Poyan	91.73
16	Neymannan	91.56
17	Alukhal	90.93
18	Kapur	88.51
19	Erachi Vazhal	80.08
20	Nallabontha	79.23
21	Kendrikela	74.07
22	Neyvannan	58.50
23	Chetty	55.53
24	Biggoe	54.33
25	Sawai	53.09
26	Kannan	40.59
27	Pachabonthabathossa	39.97
28	Malainenthan	32.25
29	Monthan	25.39
30	Karibontha	20.02

Table 3

Genetic advance after restricted selection

Character	Genetic advance
x_1	4.235
x_2	-1,228
x_3	86.484
x_4	4.983
x_5	2.369
x_6	40.988
x_7	2.128

significant phenotypic and genotypic correlations of the characters with yield were positive. From the path coefficient analysis, it was seen that the yield is influenced by the number of fingers and as the number of hands increases, the number of fingers per hand decreases. No significant gain in genetic advance was observed when the genetic advance through discriminant function was compared with that through straight selection. The analysis with restricted selection (to girth) indicated that the character, number of fingers, had the maximum genetic advance. The varieties Poykunnam and Walha were noted for their highest values of selection indices.

സംഗ്രഹം

കേരള കാർഷിക സർവകലാശാലയുടെ കണ്ണാറ വാഴ ഗവേഷണ കേന്ദ്രത്തിൽ വെച്ച് മുപ്പതുകറിവയ്ക്കുന്ന ഇനം വാഴകളുടെ പന്ത്രണ്ട് ബാഹ്യരൂപ ലക്ഷണങ്ങളെക്കുറിച്ചുള്ള താരതമ്യപഠനം നടത്തുകയുണ്ടായി. പടലയുടെ തൂക്കം, പടലയിലെ കായ്കളുടെ എണ്ണം, കായ്കളുടെ തൂക്കം ഇവ വിളവു വർദ്ധനവിനെ സാരമായി സഹായിക്കുന്നതായി കാണാൻ കഴിഞ്ഞു. പേക്കുന്നൻ, വാഴ്ഹ എന്നിവ മെച്ചപ്പെട്ട ഇനങ്ങളാണെന്ന് പരീക്ഷണങ്ങൾ തെളിയിച്ചു.

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