

PHENOTYPIC STABILITY OF COCONUT CULTIVARS IN THE INITIAL YEARS OF BEARING

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ABSTRACT

Phenotypic stability for annual yield of nuts in 11 coconut cultivars planted during 1972 were compared by means of rank stability statistics after correcting the data for genotypic effects as well as for differences in pre-bearing periods. The cultivars were grouped for stability differences following multiple comparison procedure. Results showed that the Philippines Ordinary, Cochin China and Andaman Ordinary are more stable cultivars than Ayiramkachi, Gangabondam, Federated Malay States and Laccadive Micro.

INTRODUCTION

Agroclimatic conditions are known to have significant influence on nut production in coconut. Information on phenotypic stability and genotype -by-environment interaction are therefore, essential for comparison of yield among coconut cultivars over years. Following Eberhart and Russel's (1966) regression approach, Patil *et al.*, (1991) investigated the nature of GE interaction among 9 coconut cultivars by considering each year as a separate environment. However, as Balakrishnan *et al.* (1991) pointed out, non-parametric methods seem to be more appropriate in the case of perennials as the observations over the years are likely to be not independent. They employed two non-parametric stability measures proposed by Nassar and Huhn (1987) to compare the phenotypic stability among 32 coconut cultivars. In the present study, the phenotypic stability of 11 coconut cultivars in the initial years of their bearing is compared.

MATERIALS AND METHODS

Eleven coconut cultivars viz., Andaman Ordinary (AO), Cochin China (CC), Java Giant (JG), West Coast Tall (WCT), Andaman Giant (AG), Federated Malay States (FMS), Fiji Tall (FT), Laccadive Micro (LM), Philippines Ordinary (PO), Ayiramkachi (AK) and Gangabondam (GB) planted during 1972 in the sandy loam soil under rainfed condition at Central Plantation Crops Research Institute, Kasaragod, formed the material for the study. The annual yield data

of eight palms in each of the 11 coconut cultivars from the start of bearing to 1991, were used for the analysis.

The observed phenotypic mean value of the genotype i ($i = 1, \dots, K$) in the environment j ($j = 1, \dots, N$) is denoted by X_{ij} . The stability statistics proposed by Nassar and Huhn (1987) are based upon ranks of the corrected X_{ij} values, correction being for the genotypic effects; that is $X_{ij}^* = X_{ij} - (X_i - \bar{X}_{..})$; where

$$\bar{X}_i = \frac{1}{N} \sum_{j=1}^N X_{ij} \text{ and } \bar{X}_{..} = \frac{1}{NK} \sum_{i=1}^K \sum_{j=1}^N X_{ij}$$

The genotypes are then assigned ranks within each environment separately, giving rank 1 for the lowest value and rank K for the highest. Let r_{ij} be the rank of cultivar i in the environment j . The rank stability statistics are then

$$S_1 = \frac{2 \sum_{j=1}^{N-1} \sum_{i=j+1}^N |r_{ij} - r_{ij'}|}{N(N-1)}$$

and

$$S_2 = \frac{\sum_{j=1}^N (r_{ij} - \sum_{i=1}^N r_{ij}/N)^2}{N-1}$$

As a stable cultivar is expected to receive similar ranks in all the environments, the values of these two statistics of such cultivars will be of smaller magnitude.

The null hypothesis that all the cultivars have the same phenotypic stability is tested by

the following statistic, S_m ($m = 1, 2$) which under the null hypothesis is approximated with a chi-square distribution with K degrees of freedom.

$$S_m = \frac{\sum_{i=1}^K \{S_i m - E(S_i m)\}^2}{V(S_i m)}; \quad m = 1, 2.$$

In which,

$$E(S_i 1) = (K^2 - 1)/3K$$

$$E(S_i 2) = (K^2 - 1)/2$$

and

$$V(S_i 2) = (K + 1) \{ (6K^3 - 6K^2 + K - 16)/30 - (N - 3) (K^3 - K^2 - K + 1) / (N(N-1) 144) \}$$

The variance of $S_i 1$ for values of $K = 4$ to 20 and $N = 4$ to 30 are tabulated in Nassar and Huhn (1987). If the aforesaid chi-square test is significant, the stability differences among cultivars can be tested by the standard procedures for multiple comparisons among the observed $S_i m$ values: The df should be taken as infinity as the variance of $S_i m$ is known in this case.

The intra- as well as inter-cultivar variation in pre-bearing period pose problems in comparison of annual yield data for the initial years of bearing. Hence, before attempting stability analysis it could be appropriate to adjust the data for year of bearing. A simple method due to Sanders as given in Jain (1992) was used to standardize the annual yields. The method precisely involves, first to

obtain the product of ratios:

$r_{ij} = R_{12} R_{23} \dots R_{(j-1),j}$ ($j = 2, 3$, etc.)
In which $R_{i(i+1)}$ ($i = 1, 2$, etc.) is the ratio of average yield of $(i+1)$ th year of bearing to the i -th year and $r_{11} = 1$. Next, a proper curve is fitted to these empirical values and from the expected values thus obtained the conversion factors are computed as the percentage values of the first year of bearing. After having obtained the conversion factors, the later year yields are converted to the first year basis and then the data is used for stability analysis.

RESULTS AND DISCUSSION

Considerable variation exists among coconut palms for their pre-bearing periods. It varied from 7.8 years for AK to 12.0 years for PO (Table I). For the initial years of bearing, the nut yield was very low for all the cultivars, but on advancement of the bearing age, the yield increased as shown in Table I. The increase in nut yield on advancement of bearing age was also reported by Rao *et al* (1978). Irrespective of cultivars, for almost all palms high correlations were found between nut yield and bearing age. For convenience, the coefficients of correlation between bearing age and respective mean yield of cultivars were only presented in Table I.

In consequence with the aforesaid observations, a direct comparison of per palm yield of different cultivars for the same year seems to be invalid. To overcome this difficulty, the yield of second and later years of bearing were converted to the first year basis by means of

Table I. Summarized results of preliminary analyses

Cultivar	Pre-bearing period (yrs)	Mean yield for 1-4 yrs. of bearing	Mean yield for 7-10 yrs. of bearing	Correlation between yield and bearing age	R ² of regression equation to obtain conversion factors
AO	11.3 ± 1.40	15.30	64.90	0.948	0.970
CC	9.8 ± 1.12	17.47	60.15	0.977	0.978
JG	9.2 ± 1.58	19.50	51.40	0.964	0.968
WCT	9.0 ± 2.72	24.85	81.22	0.978	0.978
AG	11.2 ± 2.05	19.35	51.75	0.733	0.956
FMS	10.0 ± 1.85	18.65	49.95	0.972	0.978
FT	10.3 ± 2.72	15.37	53.02	0.979	0.975
LM	8.3 ± 1.50	71.32	148.12	0.892	0.886
PO	12.0 ± 1.60	15.47	32.22	0.966	0.965
AK	7.8 ± 1.55	33.80	93.12	0.875	0.965
GB	8.7 ± 3.06	13.35	37.05	0.891	0.909

conversion factors. To obtain the conversion factors, polynomial/polynomial-exponential regressions of order upto four were tried. The R^2 values of the regression fit for all the 11 cultivars were highly significant as seen from Table I, which implies that the fitted curves are quite adequate.

Based on eight years of annual yield data (1984-91) the rank stability statistics of the 11 cultivars were work out after correcting for the differences in pre-bearing period (Table II). The test statistics for the global chi-squared tests were found to be $S_1 = 18.94$ and $S_2 = 26.19$. Only S_2 was found to be significant as the critical value of the Chi-square test for $\alpha = 0.05$ and 11df is 19.67. In other words, the cultivars were showing significant differences for the phenotypic stability when it was estimated by the 'rank-variance' statistic, S_2 . Multiple com-

parison of S_2 values showed that the cultivars PO, CC and AO were more stable than the cultivars AK, GB, FMS and LM.

Assessment of cultivars should not be based on phenotypic stability alone; the respective performance level has also to be given proper weightage. The average rank (r_i^*) of cultivars based on the phenotypic values (i.e. without correcting Xij values for genotypic effect), number of nuts/palm/year and copra out-turn per palm/year may be taken as the measures of the performance level of coconut cultivars. It may be observed from Table II that relatively WCT had a high performance level as well as stability. Though the phenotypic performance of LM was found to be very high, the comparison may not be valid as it has the smallest nut size and lowest copra content. Nevertheless, in terms of total copra out-turn, it was

Table II. Rank stability statistics for the 11 coconut cultivars

Cultivars	S_1	S_2^*	\bar{r}_i	Average yield/palm/year+	
				Nuts (no.)	Copra turn out (kg..)
PO	1.91	2.53	2.4	32.0	7.8
CC	2.71	5.36	3.4	39.9	8.3
AO	3.00	6.21	2.9	38.9	6.2
WCT	3.32	7.55	7.4	52.8	9.3
FT	3.38	8.00	2.1	34.4	6.8
JG	3.68	9.29	6.0	36.0	6.8
AG	3.39	11.27	7.3	36.1	6.6
AK	4.36	14.86	8.7	62.5	7.8
GB	4.61	15.55	6.0	26.1	4.0
FMS	5.11	18.55	8.9	33.4	7.6
LM	4.96	20.84	11.0	108.2	9.7

* Significant at 5% level. (CD = 7.15)

+ Based on 1-10 years of bearing

Table III. Rank stability statistics (S_2) obtained when data for fewer years was used

Cultivars	1984-90	1984-89	1984-88
PO	2.92	3.44	3.55
CC	6.14	5.47	6.30
AO	4.92	5.84	3.80
WCT	8.67	8.30	8.50
FT	8.42	9.57	11.80
JG	8.15	5.64	4.20
AG	12.29	13.37	15.70
AK	15.00	14.27	14.50
GB	13.14	13.47	8.30
FMS	20.57	20.40	25.20
LM	22.14	25.50	28.20
CD ($\alpha = 0.05$)	7.81	8.69	9.92

found superior to other cultivars but it ranked lowest in terms of phenotypic stability.

Rao *et al.* (1978) emphasized the need for evaluating germplasm accessions at an earlier stage. The adequacy of using less number of years' data was investigated by considering data for fewer years such as 1984-90; 1984-89 etc. The results are presented in Table III. The order of the stability measure of GB changed considerably when the data was limited for 1984 to 88 whereas when the data for 1984-87 was used, no significant differences were found among cultivars. The results were found to be comparable for 1984-89, 1984-90 and 1984-91 and thereby it seems that a minimum of six years data is sufficient for comparing cultivars for phenotypic stability.

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DISCUSSION

C.S. SRINIVASAN: A comparison in other stability models such as Eberhart and Russel may be made for ranking of cultivars.

MURALIDHARAN: As observations of subsequent years are likely to be dependent, regression approach of Eberhart and Russel may not be proper.

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