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VIGOUR INDEX AS AN ADDITIONAL PARAMETER IN IDENTIFYING ELITE PALMS IN ARECANUT

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ABSTRACT

Multiple regression and path analysis was attempted to study the causal relationship of the yield and ten vigour variables for the local South Kanara variety of arecanut. Palm height, internodal distance at permanent mark and maximum length of leaf sheath showed high correlations and high direct effects, whereas the girth at permanent mark had a high negative direct effect, but its positive correlation with yield was largely due to highly positive indirect effect via palm height, thereby indicating the importance of these four vigour variables in identifying the actual potential elite areca palms. A vigour index is formulated by regressing these four selected variables on the yield and a selection criterion is proposed to select elite areca palms using yield and vigour index.

INTRODUCTION

Plant yield in general, a complex entity determined by the interplay of a number of attributes and it is more complex in a perennial crop such as arecanut. Adequate knowledge of inter-relation of factors influencing such a complex character is essential for application in selection of elite palms in a garden, yield forecast and so on.

When it comes to selection of elite palms for collecting the seed material, it is a common practice to search for the high yielding mother palms. The fact that the yield heritability for arecanut is low as reported by Bavappa and Ramachander (1967a) and Bhagavan et. al. (1981). it necessiates search for additional parameter which expresses the genotypic structure of the palm phenotypically and which have direct or indirect bearing on yield of the palm. Bavappa and Ramachander (1967b) have established positive correlation for some of the seedling variables and yield of arecanut. Bhagavan (1982) has highlighted the influence of seed and seedling variables on the yield of arecanut. The vigour variables of the adult palm which remains more or less stable after the palm establishes itself, presumably play a significant role in influencing the yield. Keeping this in view, both multiple regression analysis and path co-efficient analysis are attempted to select variables which are of indicative importance. Based on these variables identified a vigour index has been arrived at and a procedure has been outlined for refinement in selection of elite palms.

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MATERIALS AND METHODS

From an experiment involving 18 types of South Kanara variety of arecanut replicated three times, laid out in 1966 at Central Plantation Crops Research Institute, Regional Station, Vittal, the data on ten vigour variables in 1976-77 and yield data on weight of nuts (Y) averaged over four years (1973-74 to 1976-77) were collected. The vigour variables were: palm height (X_1), girth at permanent mark (X_2), girth at last exposed node (X_3), internodal distance at permanent mark (X_4), internodal distance below the crown (X_5), number of nodes (X_6, leaf sheath maximum length (X_7, leaf sheath maximum breadth (X_8), number of leaves (X_9) and length of largest leaf (X_{10}).

Since the experiment was laid out in RBD, with the model $y_{ij} = \mu + r_i + t_j + e_{ij}$; i = 1,2,3 and j=1,2...18
with the usual assumptions, where i classification refers to replications and j classification refers to types, all the data on yield and vigour variables were transformed to uniformity trial data with the model.

$y_{ij} + \mu + e_{ij}$; i=1,2,3 and j=1,2.....18
by eliminating the replication effect and effect and due to types. Similar such transformation was done for estimating optimum size and shape of plot from fertilizer trial data (Ray et al., 1973).

Two models $Y = a + \Sigma b_i X_i$ ..... (A)
$Y = a \Pi X_i^{b_i}$ ..... (B)

of regression were fitted to the transformed data and after deleting the variable which had very low correlation with the yield, path co-efficient analysis developed by Wright (1921) was carried out to study the direct and indirect effects of the vigour variables in relation to yield.

Four vigour variables were selected based on path co-efficient analysis and a vigour index has been arrived at by regressing these four variables on yield.

Given below is a procedure for selection of elite palms which ensures not only high yield but also high vigour.

Step 1 : Select a desired percentage of palms based on yield
Step 2 : Select same percentage of palms based on vigour index
Step 3 : Pick out those as elite palms which are common to these two groups of selected palms.

As an illustration, from the present population 12 palms were selected based on step 1 and 12 palms were selected based on step 2. The 6 palms which were common among these were identified as elite palms.

RESULTS AND DISCUSSION

The mean values, standard errors and correlations with yield for the various characters studied are presented in Table I. All vigour variables have shown positive correlation with yield, thereby indicating that a good vigoured plant results in a better yield mostly. It is observed that palm height internodal distance at permanent mark and maximum length of leaf sheeth have shown significant positive correlations with the yield.

The multiple regression analysis for the models (A) and (B) indicated R^2 to be of

Table I. *Mean, Standard Errors and Correlations of various characters*

Characters	Mean	Standard Error	Correlation with wt. of nuts
Palm height (cm)	5.33	0.08	0.50**
Girth at PM (cm)	45.66	0.37	0.11
Girth at LEN (cm)	34.31	0.27	0.20
Internodal distance at PM (cm)	13.98	0.19	0.40**
Internodal distance BC (cm)	7.14	0.12	0.21
Number of nodes	51.06	0.44	0.25**
Leaf sheath Max. length (cm)	89.18	0.51	0.32*
Leaf sheath Max. width (cm)	37.86	0.46	0.21
No. of leaves	10.40	0.07	0.25
Length of largest leaf (m)	1.80	0.02	0.07
Wt. of nuts (kg)	3.24	0.18	1.00

PM – Permanent Mark, LEN – Last Exposed Node, BC – Below crown
*Significant at 5% level
**Significant at 1% level

order 44.3% and 43.4% respectively which means that the multiplicative model (B) is not of any special advantage over the linear model (A). It may however, be observed that the vigour variables which remains more or less stable over a period of time has a significant contribution ($F = 3.42 > F_{10,43;\ 0.05}$) with 44.3% predictability.

Since the correlation co-efficient by itself does not give a true picture about the causal relationship, path co-efficient analysis was attempted for all the vigour

Table II. *Correlation matrix between nine vigour variables*

Characters	1	2	3	4	5	6	7	8	9
1. Palm height	1	0.52**	0.65**	0.430**	0.47**	0.49**	0.14	0.33	0.43**
2. Girth at PM		1	0.40**	0.33*	0.23	0.20	0.13	0.24	0.32*
3. Girth at LEN			1	0.10	0.35*	0.36**	0.08	0.38**	0.52**
4. Internodal distance at PM				1	0.05	0.40**	0.05	0.00	0.07
5. Internodal distance BC					1	-0.22	-0.19	0.08	0.17
6. No. of nodes						1	0.24	0.07	0.09
7. Leaf sheath Max. length							1	0.24	0.14
8. Leaf sheath max. width								1	0.21
9. No. of leaves									1

*Significant at 5% level
**Significant at 1% level

Table III. *Correlations and path co-efficients showing direct and indirect effects of nine attributes on wt. of nuts*

Characters	1	2	3	4	5	6	7	8	9	Correlation with wt. of nuts
1. Palm height	.48	−.15	−.10	.13	.05	−.03	.04	.02	.06	0.50
2. Girth at PM	.25	−.28	−.06	.10	.02	−.01	.04	.01	0.11	
3. Girth at LEN	.31	−.11	−.16	.03	.04	−.02	.02	.02	.07	0.20
4. Internodal distance at PM	.21	−.09	−.02	.30	.00	−.02	−.01	.00	.01	0.40
5. Internodal distance BC	.22	−.06	−.06	.02	.10	.01	−.05	.01	.02	0.21
6. No. of nodes	.23	−.06	−.06	.12	−.02	−.05	.07	.01	.01	0.25
7. Leaf sheath Max. length	.06	−.04	−.01	.01	−.02	−.01	.29	.02	.02	0.32
8. Leaf sheath Max. width	.16	−.07	−.06	.00	.01	.00	.07	.06	.03	0.20
9. No. of leaves	.20	−.09	−.08	.02	.02	.00	.04	.01	.13	0.25

Underlined figures denote direct effects.

variables excepting one i.e., length of largest leaf which has 0.07 correlation with yield. The correlation matrix for the nine vigour variables and the yield is presented in Table 2 and the path diagram of these nine attributes on yield is depicted in Fig.1. The estimates of direct and indirect effects are presented in Table 3. The path co-efficient analysis showed that the direct effects of palm height internodal distance at permanent mark and maximum length of leaf sheath were high and positive in accordance with their correlations with yield. Although the girth at permanent mark and high negative direct effect, its positive correlation with yield was obtained largely due to its high indirect effect via palm height. All the remaining characters too had high indirect effect via palm height, but their individual direct effects were not that marked. These results indicate the importance of palm height, internodal distance at permanent mark, maximum length of leaf sheath and girth at permanent mark for their contribution to yield.

The importance of height, girth and internodal distance even otherwise is justified in earlier studies of Bavappa and Ramachander (1967). But they had considered seedling vigour in relation to yield and had established strong relationship. Our study upholds this result for the adult palm vigour.

After having established the importance of palm height, girth at permanent mark, inernodal distance at permanent mark and leaf sheath maximum length, with these four variables and yield, multiple regression analysis was again carried out and found that R^2 is 40.4% and is significant ($F = 8.30 > F_{4,49;0.05}$). This expresses nearly 91% contribution of all the 10 variables put together. The regression equation with these 4 variables.

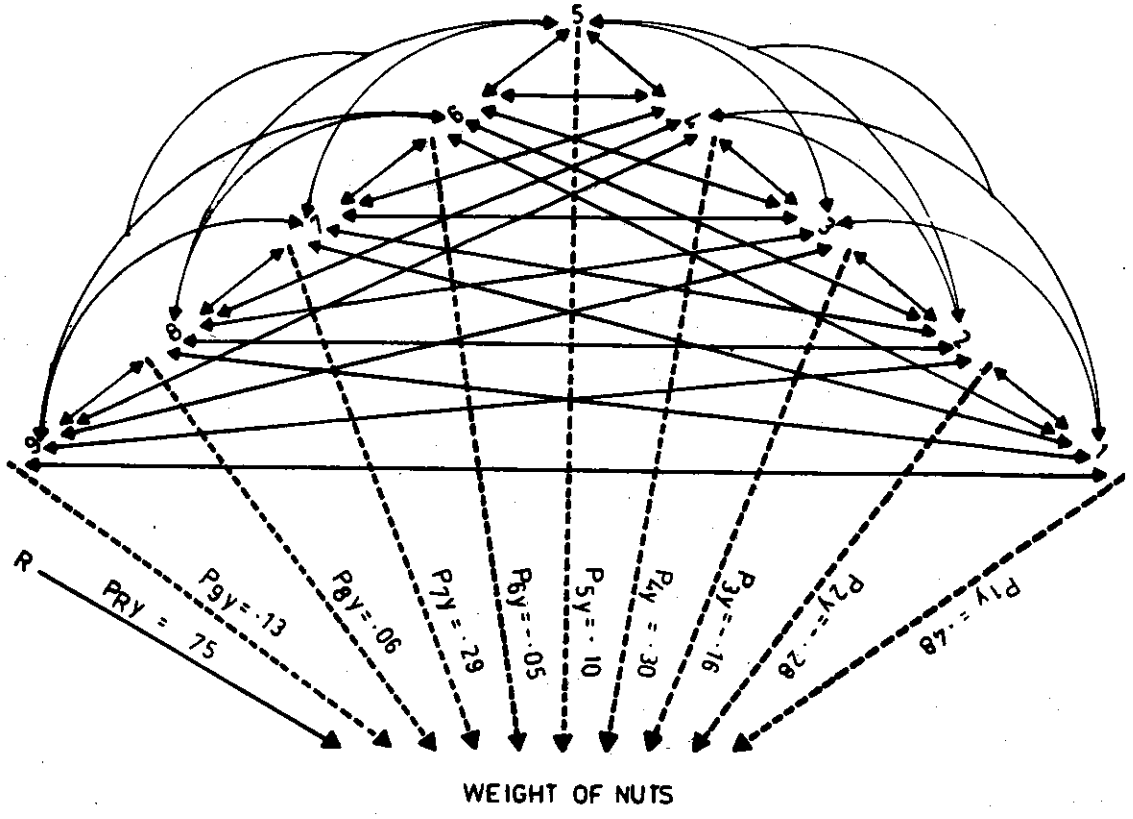

Fig. 1. Path diagram showing direct and indirect effects. Dotted lines with unidirectional arrows represent direct effects, bi-directional arrows represent correlation co-efficient between two arrow heads for (1) Palm height, (2) Girth at PM, (3) Girth at LEN, (4) Internodal distance at permanent mark, (5) Internodal distance below crown, (6) Number of nodes, (7) Leaf sheath maximum length, (8) Leaf sheath maximum breadth and (9) Number of leaves.

$$I = -8.23 + X_1 - 0.13\ X_2 + 0.25\ X_4 + 0.09\ X_7$$
$$(.28) \qquad (.06) \qquad (.11) \qquad (.04)$$

may be considered as the vigour index, where the values within bracket denote standard errors for regression co-efficients.

Selection of elite palms as detailed above, ensures both high yield and high vigour of palms. This may be more precise than selecting elite palms on yield alone which has low heritability. In the illustrative example, the six palms which meets selection norms based on both yield and vigour index are ranked 1,2,3,5, 10 and 11 with respect to yield alone. The palms ranking 4 and 6 in respect of yield were observed to have 14 and 18 as their vigour index ranks indicating that their high yield may be due to locational advantage and genotypically they may not have potential as indicated by its vigour parameters considered.

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