SELECTION INDEX IN ARECANUT

P. R. RAMACHANDER* and K. V. A. BAVAPPA

Central Plantation Crops Research Institute, Kasaragod, Kerala, India

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INVESTIGATIONS on the breeding methodology of arecanut (*Areca caltechu* L.) have been reported by Bavappa and Ramachander (1967, a, b; 1968, a, b). While discussing the problems relating to breeding for higher yield in this crop, it has been suggested by them that mother palm selection based on selection index may be useful in achieving quick gains in yield. The present paper reports the working out of selection index for the Vittal type of arecanut.

MATERIALS AND METHODS

The following 17 growth measurements taken at various stages of growth and 12 yield components as well as cumulative yield for first four years of 220 palms belonging to 10 mother palms (families) grown under uniform conditions at the Central Plantation Crops Research Institute, Vittal were used for calculation of selection index.

Growth measurements: X_1—No. of leaves, X_2—Girth at collar (cm), X_3—Height (cm), all recorded at the time of planting; X_4—No. of leaves, X_5—Girth at collar (cm), X_6—Height (cm), X_7—No. of nodes, all recorded after one year growth in the main field: X_8—No. of leaves, X_9—Girth at permanent mark (cm), X_{10}—Girth at last exposed node (cm), X_{11}—No. of nodes, all recorded after two years growth in the main field; X_{12}—No. of leaves, X_{13}—Girth at collar (cm), X_{14}—Girth at permanent mark (cm), X_{15}—Girth at last exposed node (cm), X_{16}—Total height from permanent mark to last exposed node (cm) and X_{17}—No. of nodes, all recorded after six year growth in the main field.

Yield components: X_{18}—No. of leaves shed, X_{19}—No. of inflorescences produced, X_{20}—No. of bunches harvested, X_{21}—Total No. of female flowers produced, X_{22}—Total No. of fruits set, all per tree per year; X_{23}—Percentage of fruits set; X_{24}—Mean weight per nut (gm); X_{25}—Mean No. of nuts per bunch; Percentage of bunches harvested to inflorescence—X_{26}, Inflorescence to leaves produced—X_{27}, Nuts harvested to nuts set —X_{28}, Kernel to wet weight—X_{29}; X_{30}—Cumulative yield (number of nuts) yield during first four years of bearing.

The additive genetic variance and covariance matrix between all the characters were calculated using the method of half sib analysis as given by Liyanage and Sakai (1961). Selection index for the different groups of characters and genetic advance due to them were calculated by the method given by Smith (1936) and Goulden (1959). In the selection index, zero weights were given for characters X_1 to X_{29} and unit weight to X_{30}. After working out the index and calculating the index value for each of the progenies a selection differential was set up and those palms which passed the limit were selected. The computation was done using the electronic computor (IBM 1620, Model II) installed at Institute of Agricultural Research Statistics, New Delhi.

RESULTS

The selection indices and the genetic advance (G.A.) expected by exercising selection based on them as well as the relative improvement (R.I.) over straight selection based on yield are given in Table 1 for different groups of characters.

*Present address: Central Tobacco Research Institute, Rajahmundry-1.

TABLE 1

Constants of different characters for calculating selection indices, GA and RI

Character	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8
X_1	180·623	187·865		193·133	206·618			
X_2	46·043	50·933		114·644				
X_3	–6·299	–6·302		–6·551	–4·966			
X_4	2·041	3·517				3·233		
X_5	12·407	13·640				18·245		
X_6	–2·367	–2·285				–0·621		
X_7	–60·421	–68·296				–75·460		
X_8	–49·358	–54·352					–47·532	
X_9	12·126	11·435					11·480	
X_{10}	–13·341	–12·089					–14·859	
X_{11}	49·347	61·061					20·804	
X_{12}	–19·161	–33·384						9·066
X_{13}	0·871	2·757						3·388
X_{14}	–13·245	–15·140						–9·532
X_{15}	–8·203	–3·564						–7·622
X_{16}	1·152	0·909						0·744
X_{17}	–5·121	–12·667						–4·415
X_{18}	–60·308		–32·811					
X_{19}	84·710		23·316					
X_{20}	–67·710		–107·216					
X_{21}	–0·238		–0·031					
X_{22}	0·678		1·036					
X_{23}	–5·378		2·128					
X_{24}	–1·878		1·202					
X_{25}	0·509		–3·401					
X_{26}	1·529		0·881					
X_{27}	–3·706		–1·997					
X_{28}	0·968		6·339					
X_{29}	–0·632		–1·427					
G.A.	284·694 K	271·854 K	116·274 K	200·884 K	190·020 K	96·050 K	126·705 K	80·450 K
R.I.(%)	498·484	476·011	203·589	351·749	332·726	168·180	221·863	140·860

G.A. due to straight selection: 57·110 K where K is a constant.

Group 1: 29 characters; Group 2: 17 growth characters; Group 3: 12 yield components; Group 4: growth measures at planting; Group 5: Ht and no. of leaves at planting; Group 6: growth measures after one year; Group 7: growth measures after two years; Group 8: growth measures after eight years.

Discussion

Devising sound breeding programmes for improvement of cross-pollinated, perennial crops where vegetative propagation is not possible is one of the most difficult problems in crop improvement. This is especially so in a crop like arecanut where the heritability of yield is low. A method of selection based on age at first bearing which has high heritability and significant and high correlation with yield had earlier been suggested by Bavappa and Ramachander (1967a). But due to the limited variability in age at first bearing this method may not lead to very significant improvement. Heritability and correlations of many other characters with yield have also been worked out but none of them had the desired property for being chosen as a selection criteria. Under such a situation, selection index technique can be regarded as the limit of refinement of selection methods. Standardisation of such selection procedures is particularly useful in perennial crops where once the genetically potential parents are identified planting material can be continuously collected for a number of years. After working out the index and calculating the index value for each of the progenies a selection differential was set up and those palms which passed the limit were selected.

It is obvious that with the correct methodology and adequate population addition of every single character will improve the efficiency of the index as measured by genetic advance. The relative contribution of the different characters when they are included in the index differs from character to character. Ideally all possible combinations of characters have to be examined so as to spot out that combination which contributes maximum to the efficiency of the index. But due to the very cumbersome nature of the work and also due to the fact that a selection index with maximum efficiency applicable at a particular stage of growth will be convenient for use, a logical reduction of the characters has been done so as to arrive at a suitable combination. From the different indices and G.A. presented it can be seen that a selection index based only on growth measurements at the time of planting gives an efficiency of 332% over straight selection while all the 29 characters together give an efficiency of 498%. From the point of view of a practical breeder in spite of higher efficiency of the latter, the former will be preferred because of the ease of calculation as well as possibility of raising seed gardens with selected seed donors. For the cultivator wishing to apply the index I_5, which when the coefficient of number of leaves is made unity becomes a simple relation of multiplying the same by 40 and subtracting height can be recommended. In spite of the large number of references available on selection index in various crops, such a relative efficiency due to selection index over straight selection has been noticed only rarely.

A critical study of the different breeding methods formulated so far for the improvement of arecanut revealed that family and individual screening and the mass pedigree method of selection (Bavappa and Ramachander, 1968a, b)

cannot be theoretically compared with the selection index method. However, it appeared that the family screening coupled with screening of the individuals by the selection index or the modified mass pedigree system (Bavappa and Ramachander, 1968a, b) including a screening of individuals in step 4 and 7 by the selection index method will yield better results. Experiments for comparing these different methods of selection are being laid out at the Central Plantation Crops Research Institute, Vittal.

Summary

Selection indices, genetic advance expected by selection based on them as well as relative improvement over straight selection using 17 growth characters and 12 yield components taken as a single group and combination of certain of them in seven other groups were worked out. As against an expected genetic advance of 57·11 due to straight selection, the advance was 284·694 due to a selection index based on all the characters, a relative improvement of 498%. A simpler index using the number of leaves and height of the plant alone at the time of transplanting gave a relative improvement of 332%.

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References

Bavappa, K. V. A. and Ramachander, P. R., 1967a. The improvement of arecanut palm. *Indian J. Genet.*, **27**: 93–100.

———— and ———— (1967b). It is worthwhile selecting areca seedlings with care. *Indian Fmg*, **15**(2): 20–21.

———— and ———— (1968a). Selection in arecanut palm. *Trop. Agric.*, **123**: 25–35.

———— and ———— (1968b). Some immediate problems, possibilities and experimental approaches—Arecanut. *Indian J. Genet.*, **28**A: 135–139.

Goulden, (1959). *Methods of Statistical Analysis.* Asia Publishing House, Calcutta.

Liyanage, D. V. and Sakai, K. I. (1961). Heritability of certain yield characters of coconut palm. *J. Genet.*, **57**: 245–252.

Smith, H. F. (1936). A discriminant function on plant selection. *Ann. Eugen.*, **7**: 240–250.