

IMPROVEMENT OF ARECANUT PALM *ARECA CATECHU* L.

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PATEL (1957) while discussing the scope of arecanut improvement by breeding has recommended growing seednuts collected from open-pollinated, highly productive and well isolated gardens and growing seedlings from the crossed nuts obtained through controlled cross pollination of highly productive trees. Based on the study of dispersal of pollen in arecanut, Murthy and Bavappa (1961) have suggested a scheme for the production of *elite* seeds. Breeding problems in arecanut have not been discussed from any other angle.

MATERIALS AND METHODS

The primary aim of arecanut breeding is assumed to be to increase yield although points like quality of kernel, disease and insect resistance also deserve simultaneous consideration. At the Central Arecanut Research Station, Vittal, seedlings raised from open-pollinated seednuts collected from 41 mother palms are being compared under uniform field conditions since 1957. A total of 2966 palms in 41 families was under study. Similarly 460 palms in another set of 17 families were also under observation in a private plantation. Information on floral biology and various yield attributes of both progenies and mother palms were recorded.

RESULTS

Murthy and Bavappa (1960) recorded that in 16 percent of the palms there is overlapping of male and female phases. Bhat, Krishnamurthy and Madhava Rao (1962) reported that overlapping of male and female phases was found to occur in 16 out of 18 spadices. Even though overlapping cannot be taken as a direct index of selfing, it may be safe to consider the same as an indication of the extent of possible selfing in the crop. Large scale data gathered at this Station has shown that on an average inter-spadix overlapping takes place to the extent of 13 percent and intra-spadix to the extent of four percent, which is in conformity with the report of Murthy and Bavappa (1960). Arecanut must, then be considered to be a largely cross pollinated taxon and breeding programmes will have to be devised keeping this in view.

MOTHER PALM SELECTION

The existing method of selection of seed material, as a means of genetic improvement, consists of collection of seed from phenotypically high yielding mother palms located in gardens reputed for their average yield (Bavappa, Patel and Mohiyuddin, 1958). The progeny performance as judged from the yield (mean number of ripe fruits and mean weight of fruits per progeny of each family) of the 41 such mother palms is given in Table 1.

TABLE 1

Frequency distribution of mother palms based on progeny performance

Range in mean yield of progeny (gm.)	No. of mother palms	
	1963-64	1964-65
2000-3000	3	0
3000-4000	5	2
4000-5000	7	7
5000-6000	11	11
6000-7000	7	11
7000-8000	6	6
8000-9000	2	3
9000-10000	0	1

It will be seen that even though the mother palms have been selected for high yield there is wide variability in the performance of their progenies, the variability being more or less identical in both the years.

The data relating to the frequency distribution of the 41 mother palms in different plantations showed that mother palms having high progeny performance are present in all the gardens more or less uniformly. Selection of mother palms, giving stress to the gardens in which they are located, therefore, seems to be not advantageous.

The regular bearing habit of the mother palms in relation to the mean progeny performance was also examined for 22 palms out of the 58 for which nut count data were available. From the data it appeared that progeny performance does not have any relation with the regularity in the yielding behaviour of the mother palms.

PROGENY BEHAVIOUR

Even though the mean yield of progenies is an index of general evaluation, from the point of view of the efficiency of plantation, mean yield alone may not give a true picture of the population involved. A study of the variability of

the yield within the families may throw some light on this aspect. Besides, this approach can also make the selection of mother palms more objective than an arbitrary classification based on mean alone. Mother palms having high, medium and low mean progeny yields were selected and the percentage frequency of yields of progenies of each of the family plotted (Fig. 1).

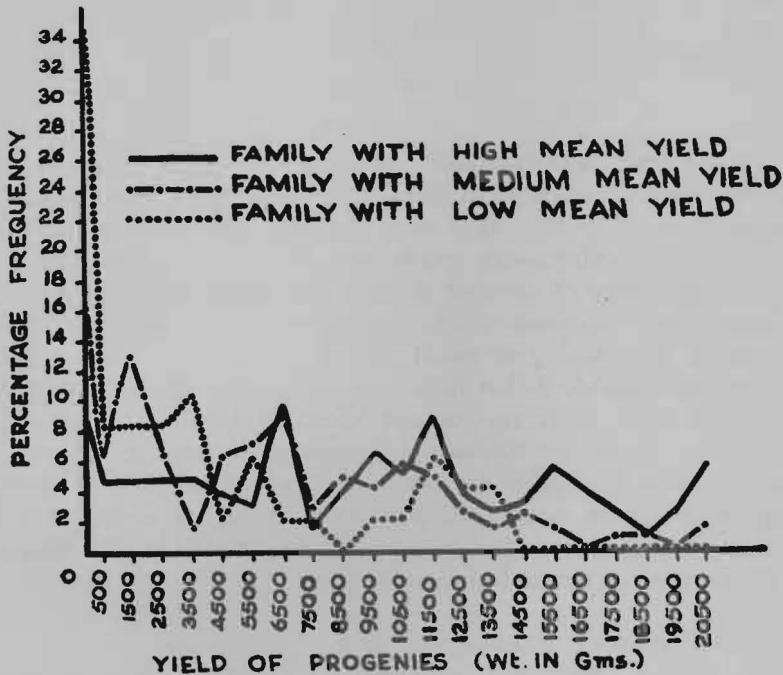


FIG. 1. Variability in progeny yields of families with different mean yields.

It will be observed from the figure that the curve for low yield group is L shaped indicating that a large proportion of progenies are low yielders, while the curve for medium yield is more or less parallel to the X-axis. The curve for high yield which should have at least approached a J shape indicating a high proportion of high yielding progenies also resembles the curve for medium yielders. Even though in our present study, we have not been able to get mother palms whose progenies have a 'J' distribution, an ideal mother palm should have a high progeny mean as well as a high concentration of high yielding progenies which will evidently give a plantation of higher efficiency.

The variability within the families was tested using the coefficient of variation. The mean coefficient of variation for the three groups of families having different mean progeny yields is given in Table 2.

It will be observed from the above that coefficient of variation is highest in the case of low yielding families followed by medium and high yielding groups.

TABLE 2
Within family variability of progenies

Yielding behaviour of families	Mean yield per palm (kg.)	Mean coefficient of variation
High	above 6	77
Medium	4 to 6	86
Low	Below 4	108

PROGENY-MOTHER PALM RELATIONSHIP

The regression between yield of mother palms and the mean yield of the progeny worked out to 0.02. It is thus apparent that there is no relationship between the progeny performance and mother palm yield under open pollinated conditions. Heritability of number of nuts per palm and the total weight of fruits per palm were also worked out from the analysis of variance between and within progenies (Liyana and Sakai, 1960).

It is seen from Table 3 that heritability is comparatively low for both the characters. The fairly wide variation in heritability values between the three years may be due to the environmental variations during these years. Taking the heritability value of number of nuts as 0.36 and mean yield of mother palm as 427 nuts the expected mean progeny yield will only be 154 nuts. This low expectation of yield suggests that practically no genetic improvement can be achieved by the present method of selection.

IMPROVEMENT BY NURSERY SELECTION

Almost without exception, workers on coconut have recommended selection of seedlings in nursery for vigour in the initial stage of growth. With a view to establish the relationship between the vigour of the seedlings in the nursery and subsequent yield of the concerned palms, phenotypic and genotypic correlations were worked out between some of the important morphological characters of the seedlings at the time of planting as well as one and two years after, with yield in the first four years of bearing for a group of 324 palms. Heritability of these morphological characters was also worked out. The values are given in Table 4.

From the phenotypic correlations it will be observed that the morphological characters at the time of planting are significantly correlated with the yield in the first year of bearing only, whereas characters recorded one and two years after planting have significant positive correlation with yield in all the four years except for the girth at last exposed node for one year. However, in the case of genotypic correlations number of leaves at the time of planting, girth at collar one year after planting and number of nodes two years after planting alone had positive and significant correlations with yield during all the four years.

TABLE 3

Heritability for no. of nuts and total weight of nuts in arecanut palm

Name of plantation	No. of families studied	Total No. of progenies	Second year of bearing				Third year of bearing				Fourth year of bearing			
			No. of nuts		Total weight		No. of nuts		Total weight		No. of nuts		Total weight	
			Heritability	Standard error	Heritability	Standard error	Heritability	Standard error	Heritability	Standard error	Heritability	Standard error	Heritability	Standard error
1. KMJ	10	929	0.44	0.13	0.48	0.13	0.23	0.09	0.24	0.09	0.44	0.13	0.42	0.14
2. SDK	11	931	0.28	0.10	0.12	0.06	0.12	0.06	0.14	0.07	0.20	0.07	0.15	0.07
3. SRJ	8	462	0.48	0.18	0.48	0.18	0.28	0.14	0.20	0.12	0.15	0.08	0.13	0.07
4. KKF	12	644	0.25	0.11	0.20	0.10	0.14	0.08	0.12	0.08	0.15	0.08	0.18	0.10
5. All the gardens	41	2966	0.36	0.06	0.33	0.06	0.19	0.01	0.18	0.01	0.20	0.01	0.20	0.01

TABLE 4

Phenotypic and genotypic correlations between morphological characters of seedlings and their yield.

Morphological characters	Phenotypic correlation with yield during				Genotypic correlation with yield during				Heritability
	First year	Second year	Third year	Fourth year	First year	Second year	Third year	Fourth year	
I year (at the time of planting)									
No. of leaves	0.21**	0.04	0.04	0.04	0.32*	0.12	0.21	0.39**	0.92
Girth at collar	0.12*	0.04	0.03	0.05	0.12	-0.35*	-0.40**	-0.16	0.96
Height	0.19*	0.06	0.06	0.06	0.36*	-0.18	-0.18	-0.15	0.80
II year (one year after planting)									
No. of leaves	0.26**	0.17*	0.12*	0.09*	0.98**	-0.32*	-0.08	-0.01	0.32
Girth at collar	0.21**	0.27**	0.16*	0.23**	0.46**	0.10	0.16	0.23*	0.80
Height	0.22**	0.27**	0.22**	0.19*	0.31*	-0.25	-0.41**	-0.27	0.32
III year (two years after planting)									
No. of leaves	0.24**	0.13*	0.15*	0.26*	0.19	-0.08	-0.09	0.14	0.32
Girth at permanent mark	0.16*	0.17*	0.14*	0.16*	0.34*	-0.15	0.68**	0.45**	0.36
Girth at last exposed node	0.19*	0.09	0.23**	0.13**	0.33*	-0.03	0.21	0.25	0.64
No. of nodes	0.20**	0.26**	0.13*	0.17*	0.39**	0.28*	0.03	0.12	0.96

* Above P 0.05 level of significance : 0.10

**Above P 0.01 level of significance : 0.20

* Above P 0.05 level of significance : 0.28

**Above P 0.01 level of significance : 0.38

DISCUSSION

Formulating programmes for genetic improvement in the case of cross-fertilized, seed propagated, perennial crops like arecanut is beset with many problems. Progeny studies conducted at this Research Station have shown that phenotypic selection of mother palms is ineffective as a means of genetic improvement and that heritability of yield is rather low. In the light of these findings, growing seednuts collected from open-pollinated, highly productive and well isolated gardens will not be of any advantage. However, it is possible that there may be some characters having high heritability values which should be considered in the selection of mother palms. The necessity of ascertaining which of the traits would be most useful for this purpose or what progress in the genetical constitution for yield could be attained if selection is made on each of these characters has been brought out in coconut by Liyanage and Sakai (1961).

The differential yielding behaviour of the families indicates that the transmitting ability of the palms with reference to this character is different for each mother palm. The high transmitters, probably possessing an exceptionally favourable combination of dominant genes, may be termed as 'prepotent' palms (Harland, 1957). Even though such mother palms are present, it is doubtful whether sufficiently large number of these plants could be identified so as to make available enough seed material for direct use. In the absence of known self-fertilised varieties, easy methods of identification of prepotents on lines suggested for coconut by Harland (1957) is not possible in arecanut. This makes the exploitation of prepotency much more difficult. As such, along with distribution of open pollinated nuts from these mother palms taking up large scale crossing of phenotypically high yielders with pollen collected from the prepotent palms seems to be the only way of utilising the limited number of prepotent palms available. Another line appears to be the study of second generation progenies of the prepotent mother palms with a view to find out whether the high yielding first generation progenies of the prepotent mother palms are similar transmitters as their mothers. If this could be established, even with a limited number of prepotent mother palms, in the course of 5 to 10 years sufficiently large sized plantations can be raised for the purpose of getting large supply of good planting material. Still another method of utilising the limited number of prepotent palms will be the establishment of isolated seed gardens. Crosses will have to be made in all combinations of prepotent parents and the seeds so obtained may be planted in isolated blocks after thorough mixing of seednuts. Seed from such a garden can be expected to be superior to the average of general population. Even though the utilisation of the genetical superiority of the prepotent palms by paired crosses has an added advantage over the above methods, spotting out such pairs which involves similar or more work as spotting out the prepotent mother palms themselves will limit its immediate utility.

The correlations obtained between the morphological characters of seedlings and the yield are of great immediate practical importance. The seedling characters such as number of leaves at the time of planting, girth at collar after one year growth in the transplanted field and number of nodes after two years of growth which alone have positive phenotypic and genotypic correlations with yield during the three individual years suggest that the selection of planting material based on the above characters at the appropriate period will be advantageous in improving the yield. The fact that these three characters have also high heritability should make the selection based on these characters more effective.

SUMMARY

Floral biology studies, progeny tests and correlation and heritability studies were undertaken in arecanut. Floral biology studies have confirmed that arecanut palm is normally cross pollinated. Mother palms of uniform standards were found to have differential transmitting ability in regard to yield. High transmitters were found to be distributed randomly in different plantations. No relationship was found to exist between the regular yielding habit of mother palms and progeny performance. The heritability for yield was found to be comparatively low. Positive phenotypic and genotypic correlations were found to exist between number of leaves of seedlings at the time of planting, girth at collar one year after planting and number of nodes two years after planting, with yield during the first four years of bearing. The limitations of the present method of selection and techniques that could be adopted for the improvement of the crop are discussed.

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REFERENCES

- Bavappa, K.V.A., Patel, G.I. and Ghouse Mohiyuddin (1958). Existing state of arecanut gardens and the possible ways of their rejuvenation. *Arecanut J.*, **9**: 46-50.
- Bhat, K.S., Krishnamurthy, S. and Madhava Rao, V.N. (1962). Studies on certain aspects of floral biology in the arecanut. *S. Indian Hort.*, **10**: 22-34.
- Harland, S.C. (1957). The improvement of coconut palm by breeding and selection. *Bull. Cocon. Res. Inst., Ceylon*, **15**: 1-14.
- Liyanage, D.V. and Sakai, K.I. (1960). Heritabilities of certain yield characters of the coconut palm. *J. Genet.*, **57**: 245-52.
- Murthy, K. N. and Bavappa, K.V.A. (1960). Floral biology of arecanut. *Arecanut J.*, **11**: 51-55.
- _____ and _____ (1961). Studies on the dispersal of arecanut pollen with special reference to elite seed production. *Arecanut J.*, **12**: 171-80.
- Patel, G.I. (1957). Scope of Arecanut improvement by breeding. *Arecanut J.*, **8**: 60-61.