

PATTERN OF GENETIC VARIATION IN THE REPRODUCTIVE CHARACTERS OF COCONUT

M. C. NAMBIAR AND P. S. RAVINDRAN

Central Plantation Crops Research Institute, Kasaragod

The inflorescence of the coconut palm (*Cocos nucifera* L.) is monoecious having 30-40 spikes, bearing both male and female flowers. The number of female flowers on an inflorescence is very variable and wide variations within and between varieties have been recorded by earlier workers (Sampson, 1923; Jack and Sands, 1929). Since female flower production and fruit set are important components of yield, the pattern of genetic variation for such reproductive characters in coconut is of interest. Due to seasonal variation in the reproductive potential and the ultimate number of nuts that can be harvested (Patel, 1938; Menon and Pandalai, 1958; Nambiar, Mathew and Kamalakaran (1970) a comparison of the different varieties for the number and distribution of female flowers and the proportion of set in different categories of spikes has been undertaken for two consecutive years in established palms belonging to 12 different cultivars. A comparison of open-pollinated and inbred progenies has also been undertaken and changes in the means and variances examined to find out varietal differences for the above attributes and the results are reported in this paper.

MATERIALS AND METHODS

The open and self-pollinated progenies of 45 palms of 12 cultivars were planted in 1940 in well drained sandy loam soil of Central Coconut Research Station, Kasaragod under uniform cultural and manurial treatment. The plants had attained stability in bearing when the observations were recorded. Data collected at monthly intervals for two consecutive years from July 1964 to June 1966 on the number of female flowers per spike, number of female flowers produced, total number of spikes, number of sterile spikes, number of spikes with one female flower, number of spikes with two female flowers, number of spikes with more than two female flowers, proportion of set in each category of spikes and total percentage of set were statistically analysed.

The number of female flowers produced and number of set per tree and the distribution of spikes with 0, 1, 2 and more than two female flowers were also examined for each of the ten categories of palms, producing 100 to 1000 female flowers during the two-year period. The class interval was 100 female flowers.

RESULTS AND DISCUSSION

A comparison of means (Table 1) showed substantial difference between cultivars for mean number of female flowers per spike. The

TABLE 1a : Distribution of female flowers on spikes and their percentage set—open pollinated progenies

Characters	Lacca- dive (115)*	Fiji (70)	Philip- pines (61)	Cochin- China (18)	New- Guinea (27)	S.S. Andaman (49)	Green (62)	Big Kappadam (92)	W.C. Tail (54)	Gen. Mean
No. of female flowers/spike	0.458	0.531	0.552	0.360	0.220	0.734	0.553	0.392	0.290	0.440
Total No. of spikes/bunch	32.960	40.610	39.440	33.200	37.280	32.340	46.540	38.320	40.640	37.460
Percentage of sterile spikes/bunch	52.800	51.300	43.500	64.600	77.700	27.100	49.700	43.500	67.800	54.900
Percentage of spikes with one female flower/bunch	45.400	46.500	52.600	35.100	22.300	67.400	47.100	56.300	31.900	43.300
Percentage of spikes with two female flowers/bunch	0.200	1.000	1.300	0.300	0	2.400	0.500	0.100	0.200	0.6
Percentage of spikes with more than two female flowers/bunch	1.600	1.200	2.600	0	0	3.100	2.700	0.100	0.300	1.2
Percentage set in spikes with one female flower	45.530	41.620	38.160	37.040	55.930	39.590	35.590	45.000	48.940	42.700
Percentage set in spikes with two female flowers	5.100	0	10.780	0	0	16.320	5.350	5.000	0	4.260
Percentage set in spikes with more than two female flowers	7.220	0	1.780	0	0	9.880	1.970	-	-	0.300
Total percentage set in all the spikes	39.300	38.230	26.080	35.510	55.93	34.400	32.300	42.200	48.590	39.06

*Number of bunches studied

TABLE 1b : Distribution of female flowers on spikes and their percentage set—self pollinated progenies

Characters	Lacca- dive (112)*	Fiji pines (34)	Philip- pines (32)	Cochin- China (33)	New- Guinea (27)	Andaman (49)	S.S. Green (57)	Kappadam (27)	Dwarf Green (67)	Dwarf Orange (49)	Gen. Mean
No. of female flowers/spike	0.749	0.660	0.610	0.520	0.890	0.615	0.394	0.980	0.911	0.714	0.704
Total No. of spikes/bunch	29,100	31,830	33,730	34,800	33,930	42,700	31,970	39,000	29,450	30,810	33,73
Percentage of sterile spikes/bunch	28.5	36.9	43.1	49.3	28.4	40.0	59.1	40,400	29.10	29.80	38.5
Percentage of spikes with one female flower/bunch	65.4	61.3	53.5	49.9	60.2	58.8	40.5	40,900	60.8	69.10	56.0
Percentage of spikes with two female flowers/bunch	5.9	1.5	3.0	0.7	6.8	1.0	0.3	9,300	5.0	0.90	3.4
Percentage of spikes with more than two female flowers/bunch	0.2	0.3	0.4	0.1	4.6	0.2	0.1	9,400	5.1	0.20	2.1
Percentage set in spikes with one female flower	42.27	50.56	46.10	29.64	38.83	40.20	27.87	40.02	24.43	35.87	37.58
Percentage set in spikes with two female flowers	6.33	0	0	0	8.51	0	11.38	21.86	3.59	—	5.7
Percentage set in spikes with more than two female flowers	0.61	0	0	0	1.32	0	4.09	4.32	1.09	—	1.3
Total percentage set in all the spikes	32.94	28.63	43.56	28.75	29.44	39.26	20.30	22.24	18.80	33.76	29.77

*No. of bunches studied

differences were marked for characters like total number of spikes, percentage of sterile spikes and proportion of flower set and limited for percentage of spikes with two and more than two female flowers. The differences between the open-pollinated and inbred progenies were large for number of female flowers per spike, percentage of sterile spikes, and percentage of spikes with two female flowers and small for percentage of spikes with more than two female flowers and proportion of female flower set. The differences were limited particularly for percentage of spikes with one female flower and more for number of spikes with two and more than two female flowers. The percentage set in spike with one female flower was similar in open-pollinated and inbred progenies and also when all the spikes were taken together.

The number of female flowers produced and number set per tree and the distribution of spikes with 0, 1, 2 and more than two female flowers presented in Table 2 showed considerable variation in female flower production and fruit set. Although the number of female flowers produced per palm varied from 100 to more than 900 in the two-year period, the set per tree was not directly related to the total number of female flowers. Actually the highest set was obtained from the four categories in the range of 400-800 female flowers. There was a sharp reduction in percentage of set when the number of female flowers was more than 800. Therefore, there appeared to be an intermediate optimum for female flower production to get high yield. The mean number of female flowers per spike also appeared to have an optimum which again was in the range of 400-800 female flowers. Therefore, an increase in the mean number of female flowers per spike over an optimum level resulted in a corresponding fall in the proportion of set. A comparison of the total number of spikes per tree revealed only limited differences between the ten categories of female flower production. Therefore, the distribution of spikes with 0, 1, 2 and more than two female flowers was related to the productivity. Actually, the difference in the pattern of distribution was substantial between the ten categories. In the four categories having the maximum set per tree, the number of spikes with one female flower varied from 413-582. The number of spikes with one female flower is much less in first three categories; whereas the increase in the last two categories was not much. Moreover, the number of sterile spikes is nearly half in high productive group (4 categories) as compared to its high percentage in the first four groups. Although there was a progressive increase in the number of spikes with two and more than two female flowers with increase in the number of female flowers, it did not appear to be related with the ultimate set. In fact, there was a sharp rise in number of spikes with two and more than two female flowers per spike and corresponding decrease in percentage and number set in categories producing more than 800 female flowers. Therefore, it appears necessary to select trees with large number of spikes

TABLE 2 : Distribution of female flowers and fruit-set in relation to female flower production

Total No. of female flowers produced in two years	No. of female flowers per bunch		No. of female flowers per spike		Set per tree		Total No. of spikes		No. of Spikes with sterile spikes per tree		No. of Spikes with 2 female flowers per tree		No. of Spikes with more than 2 female flowers per tree	
	Mean	Variance	Mean	Variance	Number	Percentage	of spikes per tree	sterile spikes per tree	one female flower per tree	2 female flowers per tree	more than 2 female flowers per tree			
101—200	4.8	..	0.13	0.11	43	36.1	948	829	119	0	0	0	0	
201—300	9.3	3.4	0.26	0.06	102	43.5	915	681	233	1.0	0	0	0	
301—400	11.8	1.5	0.29	0.11	159	43.4	1274	918	352	3.5	1.0	1.0	1.0	
401—500	15.4	3.2	0.40	0.09	204	45.6	1094	668	413	9.3	4.3	4.3	4.3	
501—600	21.2	26.3	0.56	0.03	227	41.0	1022	480	528	13.3	1.5	1.5	1.5	
601—700	19.2	1.7	0.56	0.15	220	34.1	1148	532	594	20.5	2.5	2.5	2.5	
701—800	28.3	23.9	0.58	0.04	223	29.7	1068	422	582	41.3	23.0	23.0	23.0	
801—900	30.2	1.9	0.86	0.15	184	20.8	1017	302	609	65.8	41.2	41.2	41.2	
Above 900	33.4	12.6	0.87	0.20	183	16.4	1243	399	616	101.0	127.0	127.0	127.0	

having one female flower and avoid selection for more than one female flower per spike. Simultaneously, selection should also be for lower frequency of sterile spikes, since this cannot be completely avoided. The data have clearly shown that there should be reduction in the variance of distribution of female flowers for stability of yield.

The coefficients of correlations between variance of the distribution of female flowers and the means for number of female flowers estimated for open-pollinated and selfed progenies are given in Table 3. Correlation between the variance and number of spikes with one female flower was the lowest in both open and self-pollinated. Therefore, selection for genotypes with more number of spikes with one female flower appears to reduce such variation. Correlation between proportion set per bunch and several other characters were also examined. It was the least with the number of spikes with one female flower. Correlation was negative and high in the case of number of spikes with two and more than two female flowers. Other correlations have not yielded any useful information. The results were parallel in both open-pollinated and selfed progenies.

TABLE 3 : *Coefficients of correlation*

(a) Coefficient of correlation between variance of the distribution of female flowers and	Open pollinated progenies	Inbred progenies
Total No. of female flowers	0.48*	0.93**
No. of female flowers per bunch	0.53*	0.92**
No. of sterile spikes per bunch	-0.62**	-0.46
No. of spikes with one female flower	0.01	-0.34
No. of spikes with two female flowers	0.68**	0.89**
No. of spikes with more than two female flowers	0.97**	0.98**
(b) Coefficient of correlation between percentage set per bunch and		
Variance of the distribution of female flowers in spikes	-0.59**	-0.56*
No. of sterile spikes per bunch	0.53*	0.04
No. of spikes with one female flower	-0.36	0.26
No. of spikes with two female flowers	-0.67**	-0.33
No. of spikes with more than two female flowers	-0.71**	-0.55

*Significance at $P = 0.05$ **Significance at $P = 0.01$

Although varietal differences could not be detected due to limited number of palms in each variety, it may be useful to explore further variability in the populations of 'Laccadive', 'Philippines', 'S. S. Green.', 'Andaman' and 'F.M.S. Big' for a favourable distribution of female flowers and proportion of set. Percentage set in spikes with one female flower is around 38-55 and 26-44 when all the spikes are taken together in these varieties, as compared to 26-48 and 14-38 respectively for the other varieties. Similar trend is observed in the mean and variance of the number of nuts harvested. Therefore, sampling larger populations of the above five varieties may be undertaken to explore the possibility of utilising them for hybridisation.

SUMMARY

Open pollinated and inbred progenies of twelve varieties of coconut were compared to study the pattern of genetic variation for reproductive characters and its impact on yield potential. There were substantial differences between varieties as well as between inbred and open-pollinated progenies of the same variety for number of female flowers per spike and number of sterile spikes. The differences were limited for number of spikes with one female flower and the percentage set in spikes with one female flower. The distribution of spikes with 0, 1, 2 and more than two female flowers was related to productivity but not the total number of female flowers produced per tree. An intermediate optimum for female flower production and mean number of female flowers per spike is indicated. The correlations between variance and number of spikes with one female flower and between the proportion of set and number of spikes with one female flower were low. Therefore, the selection of genotypes with low variance of distribution of female flowers and more number of spikes with one female flower appears to reduce instability in production and increase productivity. Detailed study and sampling of larger populations to explore further variability for favourable distribution of female flowers and for exploiting genetic diversity in intervarietal crosses are suggested.

ACKNOWLEDGEMENTS

The authors are greatly indebted to Dr. B. R. Murty, Project Coordinator (Millets), Indian Agricultural Research Institute, New Delhi for his guidance in interpreting the data and for suggesting modifications in the manuscript. The authors are also thankful to Shri K. V. Ahamed Bavappa, Director, Central Plantation Crops Research Institute, Kasaragod for the encouragement given, Shri A. K. Kamalakaran for helping in the recording of observations, and to Mr. M. Ravi, Computer, for helping in the analysis of data.

REFERENCES

- Jack, H. W. and Sands, W. N. (1929). Observations on the dwarf coconut palm in Malaya. *Malayan agric. J.*, 17 : 40-70.
- Menon, K. P. V. and Pandalai, K. M. (1958). *The Coconut Palm—A monograph*. Indian Central Coconut Committee, Ernakulam, S. India, pp. 384.
- Nambiar, M. C., Jacob Mathew and Kamalakaran, A. K. (1970). Studies on seasonal variation in nut production and sex expression in coconuts. *Indian J. Genet.*, 30 : 557-564.
- Patel, J. S. (1938). *The Coconut—A monograph*. Madras Govt. Press, pp. 313.
- Sampson, H. C. (1923). *The Coconut Palm*. London : John Bale Sons and Danielsson, pp. 262.