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SOME OBSERVATIONS ON THE EFFECT OF PHOTOPERIOD ON THE FLOWERING BEHAVIOUR OF THE COCONUT PALM— *COCOS NUCIFERA*, LINN.

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SUMMARY

Coconuts are harvested once every two months and the six crops for the year show fluctuations in yield. The two factors that affect yield are the number of spadices produced, and the number of female flowers that eventually reach maturity. It is observed that the number of spadices produced during the months March to September is higher than those produced during the other months of the year. The influence of the climatic factors—rainfall and daylength on this flowering behaviour was studied. Whilst rainfall does not appear to influence induction of spadix primordia, changes in photoperiod seem to affect the development of spadix primordia. During the months March to September, when the daylength is long the observation is that there is accelerated development of spadix primordia.

INTRODUCTION

In Ceylon the tall variety of coconut palm—*Cocos nucifera var. typica*—is grown on a commercial scale. The mature fruits, (commonly but incorrectly called nuts), are harvested every two months, beginning in February of each year. The six crops so harvested during a year show variations in yield. The crops harvested from about November to February are lower in number than those harvested from about April to September. A similar observation has been reported by Patel (1938 a) who noted that between 50%—60% of the annual crop is harvested from March to June while the crop from September to January is very low. Yields depend on the number of spadices produced, the number of female flowers on the spadices and the number of female flowers that eventually develop into mature fruits. Variations in any of these factors will therefore result in yield fluctuations. Liyanage (1956 a) observed that in the tall variety, 14 inflorescences are produced in a year. Patel (1938 b) reported that in a 'Regular bearer' the number of leaves and the number of spadices are almost the same, —12 per annum for most of the palms, and that seasonal variations in the production of spadices occur. Similar observations have been reported by Menon and Pandalai (1958 a) who state that the number of spadices opened in a year are influenced by cultivation and manuring. Coconut growers consider that more spadices open during the rainy seasons than during the dry periods of the year. Adequate information however on the causes that govern seasonal variations in the production of spadices is lacking. In the present study on the flowering behaviour of the coconut palm an attempt has been made to determine the possible factors that cause variations in the production of spadices.

Whyte (1946 a) referring to Garner and Allard states "Sexual reproduction can be attained by the plant only when it is exposed to a specifically favourable length of day. Exposure to a length of day unfavourable to reproduction but favourable to growth tends to produce gigantism or indefinite continuation of vegetative development, while exposure to a length of day favourable alike to sexual reproduction and vegetative development extends the period of sexual reproduction and tends to induce the ever-bearing type of fruiting". He further states that the work of Garner and Allard indicated that the length of day, except under extreme ranges such as would adversely affect normal functioning, is unique in its action on sexual reproduction. Difference in temperature, water supply and light intensity merely exert accelerating or retarding effects on sexual reproduction. The seasonal length of day however may have definite effects such as initiating or inhibiting the reproductive processes, the effect being characteristic for different species. The term photoperiod was introduced to designate the favourable length of day for each organism, and photoperiodism the response of an organism to the relative length of day, and night. Chandraratne (1964 a) observed that photoperiod induction of flowering becomes possible only after a plant has reached the phase of " Ripeness to flower ".

Chandraratne (1964 a) demonstrated photoperiod sensitivity on a number of varieties of rice and refers to other workers like Rhind (1935) who observed on Burmese rices, that three pure lines advanced their flowering date by 40 days, when the day length was shortened from 11-13 hours to 8-10 hours. He also refers to Scripchinsky (1940) who observed that the Ceylon mawis failed to flower in the south/west monsoon due to its high degree of sensitivity to the photoperiod. Moskov (1941) considered that the photoperiodic after-effect may be attributed to physiological changes which arise in the leaves while they are under the optimal photoperiodic conditions for the plant concerned. He also observed that whatever may be the nature of these processes, they appear to have such an effect on the vital activity of the leaves that the plant is enabled to form flowers and fruits under any photoperiodic condition. Whyte (1946 b) observed that a vegetative plant may be " Photoperiodically induced " by transferring it from the unsuitable conditions of long day and exposing it to a single short day. It will then flower even if kept subsequently under long day conditions. He states that a satisfactory, workable and all inclusive definition of a short day and long day plant is not available. His suggestion is that a long day plant is one that ceases or shows delayed or less profuse flowering with decreasing daylength and a short day plant is one that begins or shows hastened or more profuse flowering when the length of day is shortened.

MATERIAL

This study is based on data pertaining to the dates of emergence of spadices that have been compiled in the Botanist's Division of the Coconut Research Institute (Ceylon) on 20 mature mother palms of the *typica* variety at Marandawila Estate, Bingiriya in the Kurunegala District, and 23 mature mother palms of the same variety at Letchemy Estate, Nattandiya in the Chilaw District. At both places the palms in question have been regularly manured, occur randomly distributed and are subject to both the south west and the north/east monsoon rains.

DATA

The data pertaining to the experimental palms at Marandawila Estate are from January 1964 to December 1967 and for Letchemy Estate from January 1957 to December 1960.

The number of spadices that emerged in a year from each of the experimental palms appears in Table I and II, whilst information pertaining to the monthly emergence of spadices from the same palms is charted in Tables III and IV.

TABLE — I

Number of Spadices that emerged per annum

(20 palms at Marandawila)

YEAR	PALM NUMBERS																				Overall Mean
	4	26	73	81	85	96	102	105	106	114	141	179	183	197	204	249	257	269	284	292	
1964 ...	16	13	13	14	14	14	15	13	15	16	13	14	14	15	16	12	16	16	14	15	14.40
1965 ...	14	14	14	14	17	15	14	15	15	16	15	15	14	16	16	14	17	17	15	15	15.10
1966 ...	16	12	13	14	14	13	14	14	14	15	13	14	13	16	15	11	14	16	14	14	13.95
1967 ...	15	14	14	15	15	14	15	13	15	16	15	15	15	16	16	13	17	16	15	15	14.95
																					14.6

TABLE — II

Number of Spadices that emerged per annum

(23 palms at Letchemy)

YEAR	PALM NUMBERS																							Overall Mean
	1	2	3	4	5	6	8	9	11	12	14	15	16	18	23	25	29	30	31	42	48	49	50	
1957 ...	14	12	12	15	16	14	14	14	14	14	15	16	14	15	15	15	15	12	14	12	12	16	14	14.09
1958 ...	16	14	14	16	18	15	15	16	16	15	15	17	14	16	17	15	16	15	14	15	16	15	16	15.48
1959 ...	14	14	12	17	18	16	16	17	15	15	16	17	15	15	15	15	16	14	11	13	15	17	16	15.17
1960 ...	16	15	13	17	17	16	15	15	16	16	15	17	14	16	17	15	16	16	15	14	15	16	15	15.52
																								15.1

TABLE — III

Number of Spadices that emerged (monthly average)
(20 palms at Marandawila)

	1964	*1965*	*1966*	*1967*	*Mean*	
January ..	—	22	25	26	24.2	23.6
February ...	22	23	23	24	23.0	Approx. 24.
March ...	29	28	27	27	27.7	
April ...	28	23	23	25	24.7	
May ...	28	30	31	29	29.5	26.7
June ...	24	27	26	28	26.2	Approx. 27.
July ...	30	28	25	24	26.7	
August ...	24	28	24	26	25.5	
September ...	30	28	—	24	27.2	
October ...	23	22	20	22	21.7	
November ...	23	23	20	22	21.7	22.3
December ...	27	22	21	22	23.7	Approx. 22.

TABLE — IV

Number of Spadices that emerged (monthly average)
(23 palms at Letchemy)

	1957	*1958*	*1959*	*1960*	*Mean*	
January ...	28	26	31	29	28.5	28.3
February ...	28	27	31	27	28.2	Approx. 28.
March ...	28	30	26	31	28.7	
April ...	24	33	28	29	28.5	
May ...	30	27	31	34	31.2	29.9
June ...	27	32	30	31	30 0	Approx. 30.
July ...	36	32	32	30	32.5	
August ...	30	30	30	34	31.0	
September ...	23	29	29	29	27.5	
October ...	—	32	28	23	27.6	27.4
November ...	24	26	24	33	26.7	Approx. 27.
December ...	25	32	28	27	28.0	

The number of spadices produced monthly from the palms at both places and the monthly rainfall figures for corresponding periods are illustrated graphically in Figures I and II.

The number of spadices produced monthly and the length of daylight for the corresponding periods are illustrated in Figure III. In this connection it may be noted that the variation over the years in the length of day for any month is known to be very small.

The monthly averages for the number of spadices produced from the palms at Marandawila (for the years 1964 to 1967) and the palms at Letchemy (for the years 1957 to 1960) are shown in Table V, rows (b) and (c) respectively. This table, row (a) also indicates the month during which the spadices emerged and the average daylength for that month.

OBSERVATIONS AND DISCUSSION

The coconut palm is monoecious. When the stage of "Maturity to flower" is reached, male and female flowers are produced on the spadices. A spadix arises in the axil of a leaf, and when young, is enclosed in a bract or spathe. Before the spathe opens at maturity, it may measure up to about 3½ feet in length. When a spathe opens it splits longitudinally on the ventral side to expose the spadix. At emergence a spadix consists of a central axis bearing a number of spikelets. The number of spikelets on a spadix and the number of male and female flowers produced on the spikelets vary from spadix to spadix and from palm to palm. The male flowers are small and sessile and appear in large numbers almost along the entire length of each spikelet except towards the lower region of it where generally only a single sessile female flower is produced.

The number of spadices produced in a year has been found to vary from palm to palm and year to year. The number varied from 11 to 18, more often between 13 and 16 (Tables I and II). The number of spadices produced by all the palms varied from month to month and from year to year (Tables III and IV). Examination of Figures I and II shows no relation between rainfall and the number of spadices produced.

The induction of spadix primordia in relation to rainfall was examined next. The primordium of a spadix takes about 2 years to reach the stage when the spathe just opens (Nathanael 1966). On this basis a spadix primordium formed during a particular month will produce its spadix in the same month two years later. Hence the spadices opening during the south/west (about April to June) and the north/east (about October to December) monsoons have their primordia formed during the corresponding periods two years earlier. From Tables III and IV it is seen that the number of primordia that had been formed during April to June (south/west monsoon) has been high, and the number of spadix primordia formed during October to December has been low, even lower than what had been formed during the low rainfall months preceding the monsoons. It is evident therefore that rainfall does not induce formation of spadix primordia.

The length of day and the number of spadices produced monthly from the palms at Marandawila and Letchemy show a related behaviour (Figure III). During the period the daylength is long (March to September) the monthly production of spadices from the palms at both places has generally been higher than the monthly production of spadices from these palms during the period when the daylength is shorter—(October to February, Tables III ; IV ; V). The largest number of spadices per month has been produced by the palms during the months of May to July when the daylength has been the longest, (Tables III and IV).

Whyte refers to Purvis (1934) who observed that in assigning a plant to its correct photoperiod category the time of formation of flower primordia should be considered rather than the time of emergence of the inflorescence. As previously stated herein the spadix primordia formed during a particular month produces its spadix in the same month two years later. The number of spadix primordia formed monthly during the period when the daylength is long has

TABLE — V

(Summarised Data)

	Jan.	Feb.	Mar.	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
(*a*) Day Length (hrs.-mins.) (Monthly averages)	11.46	11.54	12.04	12.16	12.26	12.30	12.29	12.20	12.10	11.58	11.48	11.44
(*b*) Number of spadices that emerged. (20 palms at Marandawila) ... Monthly averages for the period (1964–67)	24.2	23.0	27.7	24.7	29.5	26.2	26.7	25.2	27.2	21.7	21.7	23.7
(*c*) Number of spadices that emerged. (23 palms at Letchemy) ... ... Monthly averages for the period (1957-60)	28.5	28.2	28.7	28.5	31.2	30.0	32.5	31.0	27.5	27.6	26.7	28.0

FIGURE I. MARANDAWILA

NO. OF SPADICES PRODUCED MONTHLY --------
(For 20 Palms)
MONTHLY RAINFALL ————

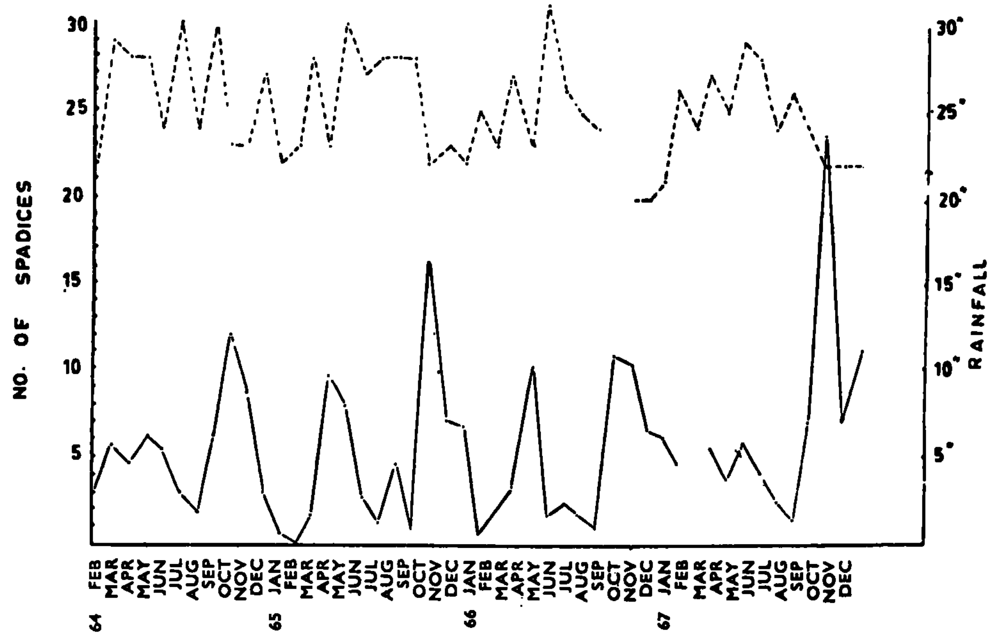


FIGURE II. LETCHYMY

NO. OF SPADICES PRODUCED MONTHLY -------
(For 23 Palms)
MONTHLY RAINFALL ————

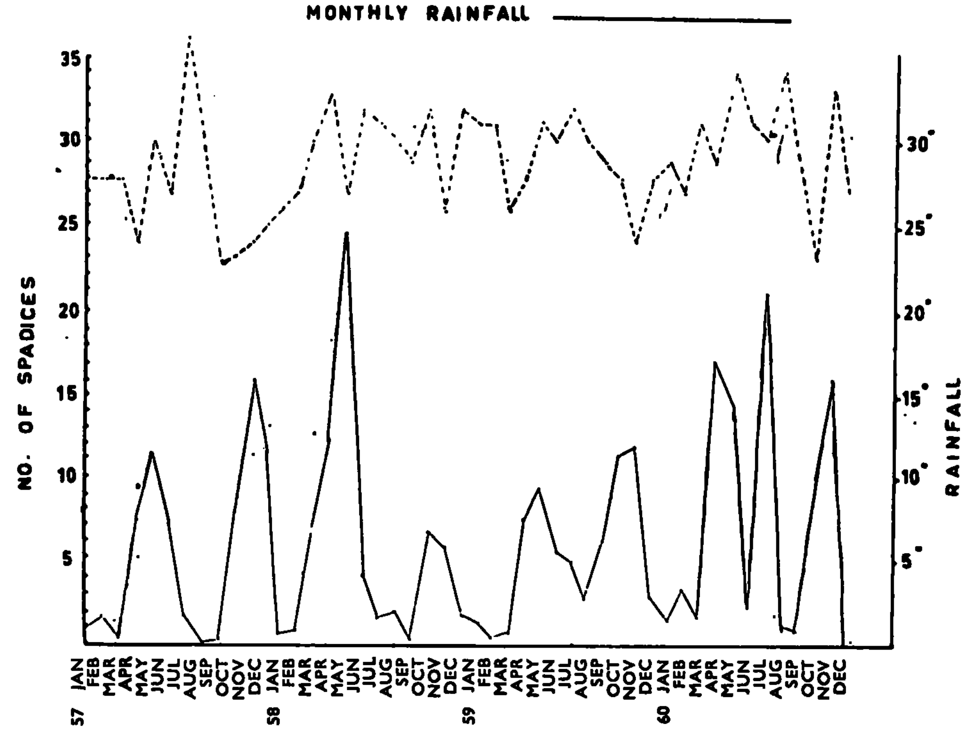
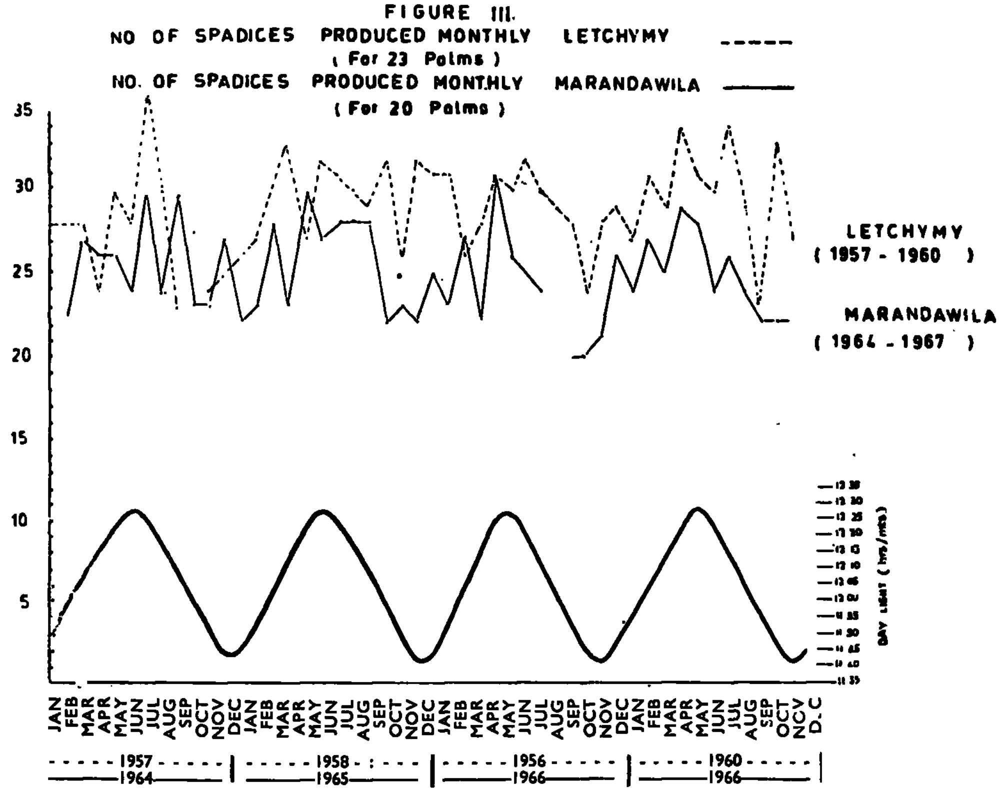


FIGURE III.


NO OF SPADICES PRODUCED MONTHLY LETCHYMY -----
(For 23 Palms)
NO. OF SPADICES PRODUCED MONTHLY MARANDAWILA ———
(For 20 Palms)
35
30
25
20
15
10
5
LETCHYMY
(1957 - 1960)
MARANDAWILA
(1964 - 1967)
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NCV D.C
1957
1964
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1966

been higher than the number of spadix primordia that has been formed monthly during the period when the daylength has been shorter (Tables III ; IV ; and V). It appears therefore that diurnal impacts of long daylengths and shorter hours of darkness induce the development of increased number of spadix primordia than short daylengths with longer hours of darkness. Since the palms produce spadices throughout the year, irrespective of the seasonal variations in daylight hours, the length of daylight during any month in a year is apparently within the optimum requirements for flowering. However, small variations in seasonal day-lengths appear to cause variations in the number of spadices produced, either by retarding or accelerating initiation of primordia and even further development. It appears therefore that the Coconut palm is sensitive to variations in daylength in so far as spadix initiation and production are concerned.

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