

Preliminary Studies on the Floral Biology of the Coconut Palm

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THE floral biology of the coconut palm (*Cocos nucifera* Linn.) appears to have received but scant attention. Considering its importance, the literature pertaining to the several aspects of the palm must be regarded as meagre. The earliest papers dealing with some observations on floral biology of this palm are those of Aldaba (1921)¹ and Furtardo (1923)². Marechal (1928)³ has made more or less a complete investigation of the dwarf palm. Some information regarding the tall variety is contained in Patel's⁴ monograph.

It is considered desirable to make not only detailed observations on the commonly grown tall variety of Ceylon but also to make a comparative study with reference to the other varieties, principally dwarf and King coconut. A systematic classification of the varieties of coconut grown in Ceylon has not been done. Hence a few notes on the varieties mentioned herein are desirable. The tall variety referred to is the palm commonly grown on a commercial scale in this Island. The palm takes 6 to 7 years to flower and remains productive for over 70 years. The dwarf is of Malayan origin, short in habit, and first flowers in $3\frac{1}{2}$ to $4\frac{1}{2}$ years. The economical life time does not last more than 30 years. Here three forms can be distinguished mainly by the colour of the epicarp of the nut: green, ivory yellow and golden yellow. The King coconut palm is rather tall in habit and is less short lived than the tall variety. The epicarp of the nut is golden yellow in colour. Locally this variety is referred to as "Thembili". Observations which follow are confined to the following aspects of floral biology:—

1. The duration of the two sexual phases with special reference to their synchrony. This was expected to throw light on the fact whether a particular variety could or could not be self-pollinated.
2. Studies on the viability of pollen with special reference to atmospheric humidity.

Floral Structure.—The number and arrangement of the floral parts in the different varieties of coconut commonly grown in Ceylon are more or less identical. They conform to the usual trimerous pattern of floral construction which is the common feature of all monocotyledons.

The Male and Female phases.—The duration of the female phase is herein computed on the basis of the stigmas. Receptivity begins when the three stigmas separate and a fluid is secreted through them. At this stage the stigmas and the upper area of the visible portion of the ovary are

whitish. The first signs of the loss of receptivity are the change in colour undergone by the stigmas from a whitish to a brownish shade: simultaneously the exudation of the fluid ceases. The duration of the male phase is taken as that period from the opening of the first male flower to that of the last within a spadix. These phases are represented in Table I.

TABLE I.—Duration of the Male and Female Phases

Variety	Palm No.	Male phase		Female phase	
		No. of days	No. of days	No. of days	No. of days
Tall palms	195	19	7	..	..
	292	21	6	..	..
	163	18	5	..	..
	204	20	5	..	..
Dwarf	488	18	10	..	..
	2649	22	14	..	..
	2647	22	15	..	..
King Coconut	2605	20	16	..	..
	494	18	14	..	..

In all the three varieties examined the male phase lasted from 18 to 22 days. Often male flowers do not remain on the inflorescence for more than one day; generally the male flowers open in the early hours of the day and are shed the same evening. There is no definite sequence of the opening of male flowers. Those that are borne on the upper half of each spikelet open earlier than those on the lower half. In the tall palms a few male flowers always open soon after the opening of the spathe, but in dwarf and King coconut instances have occurred when the first flower bloomed only after a week of the opening of the spathe.

The female phase lasts from 5 to 7 days in tall palms and from 10 to 16 days in dwarfs and King coconuts. In the tall palms, the male phase always precedes the female phase and very often there is an interval of about one to two days between the two phases. Thus there can be no self-pollination between the male and female flowers of each spadix in the tall palms. In all the observations, only one spathe opened before the completion of the female phase of the previous inflorescence of the same palm. Here again the female flowers were receptive only for one day, after the opening of the new spathe. Chances of inter-spadix pollination in tall palms are therefore rather remote and cross pollination is the general rule. In the dwarfs and King coconuts, the male and female phases overlap and consequently self-pollination is considerable. In dwarf palms the female phase begins about a week after the start of the male phase and ends near the completion of the male phase. Marechal working on Malayan dwarfs in Fiji has made similar observations.

The receptive period of individual female flowers of dwarf, King coconut and tall palms varies from two to four days. Here again there is no definite order in which they become receptive. Table II presents the duration of receptivity of individual female flowers on an inflorescence of the tall variety. The spikelets and the female flowers are numbered from the base upwards.

TABLE II.—The Period of Receptivity of Female Flowers of a Spadix from a Tall Variety Coconut Palm

No. of Spikelet	No. of Female Flower	Period of Receptivity	No. of Spikelet	No. of Female Flower	Period of Receptivity	
1	1	3 days	13	1	2 days	
	2	2 "		2	2 "	
	3	Fallen		14	1	3 "
	4	Fallen		15	1	3 "
	5	Fallen		16	1	2 "
	6	Fallen		2	2	2 "
2	1	2 days		3	2 "	
3	1	4 "		4	Fallen	
4	1	Fallen	17	1	3 days	
5	1	"	18	1	2 "	
6	1	3 days	19	1	2 "	
	2	3 "	20	1	2 "	
7	1	3 "		2	Fallen	
8	1	3 "		3	"	
9	1	Fallen		4	2 days	
	2	2 days	21	1	2 "	
10	1	Fallen	22	1	not developing	
11	1	3 days	23	—		
	2	3 "	24	1	2 days	
	3	3 "		2	Fallen	
	4	Fallen	25	1	"	
	5	3 days	26	1	2 days	
12	1	3 "	27	1	3 "	
	2	Fallen	28	1	2 "	
			29	1	Fallen	

Germination of pollen grains.—Tests were carried out to determine a suitable medium for the germination of pollen grains. Sugar and gelatine were used in different concentrations. Results are tabulated in Table III.

TABLE III.—Percentage of Germination of Pollen Grains

Time	Dwarf Pollen			Tall Palm Pollen		
	A	B	C	A	B	C
A. After 30 mins	0	0	0	30	32	0
B. After one hour	26	58	0	62	74	0
C. After two hours	38	53	0	56	75	0

A ... 5 per cent. Sugar + 2 per cent. gelatine
 B ... 10 per cent. Sugar + 2 per cent. gelatine
 C ... 15 per cent. Sugar + 2 per cent. gelatine

The intine protrudes through the rupture of the exine within half an hour after the pollen grains are left in a culture solution. Maximum germination is effected by the end of the first hour and thereafter the pollen tubes continue to elongate. For maximum germination 10 per cent. sugar plus 2 per cent. gelatine appears to be the best. In the higher concentrations of sugar, the cytoplasm of the pollen grain is plasmolysed and germination was almost nil. Marechal has obtained contrary results and has indicated that

25 per cent. saccharose showed 60 per cent. germination. In the 10 per cent. sugar plus 2 per cent. gelatine solution there was 58 per cent. germination of dwarf pollen and 74 per cent. germination of pollen from tall variety palms.

Preservation of pollen.—Pollen retains its vitality, under atmospheric conditions, only for about 3 to 5 days. In the hybridisation work connected with coconut palms, it was found necessary to keep the pollen viable sometimes even up to 10 days. Relative humidity of the atmosphere is a factor that changes constantly. Robert E. Wilson² has shown that different humidity equilibria can be produced by using various sulphuric acid solutions, in enclosed chambers.

Three desiccators were used with 18.5 per cent., 30.4 per cent. and 43.4 per cent. H_2SO_4 ; the relative humidity inside these chambers remained at a constant level of 90 per cent., 75 per cent., and 50 per cent. respectively. Fresh pollen collected from dwarf and tall variety palms were kept in the three desiccators. Germination counts were made every other day after allowing the pollen to germinate in a 10 per cent. sugar plus 2 per cent. gelatine solution. The results are given in Table IV.

TABLE IV.—Percentage of Germination of Pollen Grains kept in Desiccators with varying Concentrations of Sulphuric Acid

Age of pollen grains in days	Tall palm pollen			Dwarf palm pollen		
	Percentage of Germinations			Percentage of Germinations		
	90 per cent. R. H.	75 per cent. R. H.	50 per cent. R. H.	90 per cent. R. H.	75 per cent. R. H.	50 per cent. R. H.
2	58.5	59.4	54.2	38.6	51.4	59.8
3	15.6	41.7	56.4	9.6	38.9	46.8
5	—	50.6	43.4	—	48.7	48.0
7	—	61.6	59.7	—	52.1	40.0
8	—	42.9	71.8	—	20.6	36.2
10	—	36.1	56.7	—	19.2	40.5
12	—	8.3	67.0	—	5.6	46.0
14	—	+	44.9	—	—	20.4
16	—	—	44.2	—	—	36.0
19	—	—	40.6	—	—	9.9
21	—	—	20.6	—	—	—
24	—	—	5.8	—	—	—

On the fifth day of storage, pollen kept in the desiccator with 90 per cent. relative humidity, showed no germination. Therefore a saturated atmosphere seems to be injurious to the viability of pollen grains of coconut palms. On the other hand 40 per cent. of the pollen grains from tall palms remained viable for 19 days when kept in a desiccator with 50 per cent. R. H. Dwarf pollen is relatively more short lived and after the 7th day of storage less than 40 per cent. of the pollen grains were viable even in the 50 per cent. R. H. level. Marechal has obtained similar results and claims that 50 per cent. H_2SO_4 maintained a higher germination percentage. Tests were carried out with pollen grains stored over calcium chloride, but here pollen was more short-lived than under atmospheric conditions.

SUMMARY

1. The tall variety palms are protandrous. Interspadix pollination is rather remote. They are generally cross-pollinated.
2. In the dwarf and King coconut palms, male and female phases overlap and self-pollination is the general rule.
3. 10 per cent. cane sugar plus 2 per cent. gelatine is a favourable medium for the germination of pollen grains.
4. The viability of the pollen grains can be prolonged by storing them in a desiccator with 43.4 per cent. H_2SO_4 .
5. A saturated atmosphere seems to be injurious to the viability of pollen grains of coconut palms.

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References.

1. Aldaba, V. C. ... Philippine Agriculturist Vol. 10 (195).
2. Furtado, C. X. ... Garden's Bulletin—Straits Settlements—Vol. 3 (261).
3. Marechal, H. ... Agricultural Journal. Department of Agriculture, Fiji. Vol. 1 (16-45).
4. Patel, J. S. ... Monograph on Coconut. Government Press, Madras. (1938).
5. Wilson, R. E. ... Journal of Industrial and Engineering Chemistry, Vol. 13, No. 4 (328-32).