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SOME OBSERVATIONS ON THE REPRODUCTIVE PATTERNS OF VARIETIES AND FORMS OF THE COCONUT (*COCOS NUCIFERA* L.) IN SRI LANKA

W. P. BERTIE FERNANDO*
Coconut Research Institute, Lunuwila, Sri Lanka

ABSTRACT

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Data are presented on several aspects of the reproductive biology of varieties and forms of the coconut (*Cocos nucifera* L.) indigenous to Sri Lanka. The self fertilizing Nana and Aurantiaca varieties produce more female flowers bunch than the cross fertilizing Typica. Aurantiaca has the shortest male phase of 16 days. The form Bodiri shows the shortest female phase of two days.

INTRODUCTION

The coconut palm (*Cocos nucifera L.*) produces both male and female flowers on a simply branched inflorescence arising from the axil of each leaf. The floral morphology has been described by Menon and Pandalai (1958), and Child (1974). The flowering patterns of coconut cultivars grown in different parts of the world have been studied by several workers (Aldaba, 1921); Marechal, 1928; Liyanage, 1949; Whitehead, 1965; 1966; and Sholdt and Mitchell, 1967). However, as there is no common basis for identification and description of varieties and forms (cultivars) of the coconut, the reports are sometimes confusing for they differ in several important details. A proper understanding of the floral biology is useful for the correct implementation of breeding programmes.

The study described in this paper was conducted to obtain information on the comparative flowering behaviour of varieties and forms of the coconut grown in Sri Lanka whose major features have been described earlier by Liyanage (1958).

MATERIALS AND METHOD

The Coconut Varieties Block established at Bandirippuwa Estate consists of all the varieties grown in Sri Lanka, classified in the following manner.

Variety Typica		Variety Nana		Variety Aurantiaca	
Form *typica*	10 palms	Form: *eburnea*	4 palms	Form: *thembili*	6 palms
Kamandala	2 ,,	*regia*	4 ,,	*navasi thembili*	5 palms
Bodiri	1 palm	*pumila*	2 ,,		
ran thembili	2 ,,				
navasi	1 palm				
gon-thembili	6 ,,				
pora pol	–				
dikiri pol	–				

* Present Address: Janawasa Commission, Madampe, Sri Lanka.

Forty-seven palms belonging to the above forms (except forms *poru pol* and *dikiri pol* of the variety **Typica**) were used for the above investigation and the following observations were recorded over a two year period.

1. Duration of male phase
2. Duration of female phase
3. Number of female flowers produced per inflorescence
4. Number of mature nuts harvested.

RESULTS AND DISCUSSION

Duration of Male Phase

The duration of the male phase (*i.e.* the period, from opening of the first male flower to the shedding of the last male flower in the spikelets) is generally between 16 to 20 days, with the form *thembili* of the variety **Aurantiaca** having apparently the shortest male phase of 16 days (Table 1).

Table 1. *Duration of Male Phase (days)*

Cultivar		*No. of mean*	*Days S.E. of mean*
Variety form	**Typica**		
,,	*typica*	19.5	0.22
,,	*kamandala*	18.0	0.70
,,	*bodiri*	19.8	1.10
,,	*ran thembili*	17.1	0.62
,,	*navasi*	18.7	0.65
,,	*gon thembili*	18.8	0.45
Variety form	**Nana**		
,,	*eburnea*	20.8	0.41
,,	*regia*	18.7	0.42
,,	*pumila*	18.6	0.56
Variety form	**Aurantiaca**		
,,	*thembili*	16.0	0.30
,,	*navasi thembili*	18.0	0.33

Duration of Female Phase

According to Liyanage (1949), the female phase, lasts from 5 - 7 days in 'tall' palms and 10 - 16 days in 'king coconut' and 'dwarfs'. In the material used in this investigation the duration of the female phase (which is taken as the period from the date the first female flower turns receptive to the date on which the last female flower completes its receptive period) has varied between 2 - 6 days, with the form *bodiri* of the variety **Typica** exhibiting the shortest female phase of 2 days. The female phase in the form *typica* of the variety **Typica** lasts a little over three days. The female phase of the commonly self-fertilizing **Nana** and **Aurantiaca** last 3 - 6 days (Table 2).

Table 2. *Duration of female phase (days)*

Cultivar		No. of Days	
		mean	S.E. of mean
Variety form	**Typica**		
,,	*typica*	3.4	0.12
,,	*kamandala*	3.5	0.22
,,	*bodiri*	2.2	0.20
,,	*ran thembili*	3.5	0.28
,,	*navasi*	3.4	0.28
,,	*gon thembili*	3.0	0.15
Variety form	**Nana**		
,,	*eburnea*	3.5	0.18
,,	*regia*	6.4	0.40
,,	*pumila*	5.8	0.51
Variety form	**Aurantiaca**		
,,	*thembili*	5.3	0.24
,,	*navasi thembili*	5.2	0.30

This is shorter than that reported by Liyanage (1949), and subsequent unpublished observations made at this Institute but in agreement with the results of Whitehead (1965), where the duration of the female cycle of the 'Malayan Dwarf' is stated to be 5.6 - 6.2 days.

Degree of Inter-and Intra-Spadix Overlap:

The variety **Typica** is normally cross-fertilized while the varieties **Nana** and **Aurantiaca** may exhibit a high degree of self-fertilization due to the overlap of male and female phases on the same inflorescence. Furthermore, inter-spadix fertilization within the same palm can sometimes take place when female flowers of the older inflorescence are receptive above the time the younger inflorescence opens shedding pollen (Liyanage, 1949; Sholdt and Mitchell, 1967). According to Whitehead (1965), in the Ivory Coast the possibility of self-pollination due to the overlapping of consecutive inflorescences varies from 0 — 100 percent and is most frequent in the dry season. Charles (1961), was of the opinion that in Papua and New Guinea overlapping would be infreqeuent and self-pollination quite rare. Whitehead (1965) reports that opportunities for selfing due to inter-spadix pollination in "San Blas" and "Jamaica Tall" palms are fairly high as a new inflorescence opened before the completion of the female phase of the previous one in over 70 percent of the bunches observed. Table 3 gives the inter-spadix overlap of the varieties and forms discussed in this paper. It would appear that the degree of inter-spadix overlap varies from a few hours (forms *thembili, navasi thembili, bodiri, pumila* and *regia*) to 2 - 4 days (forms *eburnea, kamandala, ran thembili, navasi, gon thembili*, and *typica*).

The degree of overlap between inflorescences expressed as a percentage is also shown in Table 3. An overlap of 3 days and over may be considered sufficient for effective inter-spadix pollination.

Table 3. *Inner-spadix overlap*

Cultivar	No. of Days		% Overlap			
	mean	S.E. of mean	0 day	1 day	2 day	3 day and over
Variety **Typica**						
form *typica* ..	3.7	0.1798	—	—	26.7	73.3
,, *kamandala* ..	3.6	0.2131	—	—	21.6	78.4
,, *bodiri* ..	0.3	0.2285	83.3	11.1	—	5.6
,, *ran thembili* ..	3.5	0.2207	—	—	31.5	68.5
,, *navasi* ..	2.8	0.6241	15.8	21.0	21.0	42.2
,, *gon thembili* ..	1.0	0.1529	59.2	13.6	10.0	17.2
Variety **Nana**						
form *eburnea* ..	3.0	0.1849	8.9	7.6	12.0	64.5
,, *regia* ..	0.3	0.0845	76.4	15.8	3.9	3.9
,, *pumila* ..	0.2	0.1660	88.9	8.3	—	2.8
Variety **Aurantiaca**						
form *thembili* ..	0.1	0.0482	92.8	4.0	1.6	1.6
,, *navasi thembili* ..	0.8	0.1941	77.9	5.3	3.2	13.6

Table 4. *Intra-spadix overlap (days)*

Cultivar	No. of Days		% Overlap			
	mean	S.E. of mean	0 day	1 day	2 day	3 day and over
Variety **Typica**						
form *typica* ..	0.9	0.1729	64.0	12.7	10.5	12.8
,, *kamandala* ..	0.4	0.1366	75.7	15.2	5.4	2.7
,, *bodiri* ..	2.8	0.1202	—	—	22.2	77.8
,, *ran thembili* ..	2.5	0.2059	11.1	7.4	37.0	44.5
,, *navasi* ..	3.4	0.2565	—	—	21.0	79.0
,, *gon thembili* ..	3.2	0.1372	1.8	—	35.4	62.8
Variety **Nana**						
form *eburnea* ..	1.5	0.2053	38.0	25.3	11.4	25.3
,, *regia* ..	6.4	0.3247	—	1.3	3.4	94.8
,, *pumila* ..	5.2	0.5032	—	2.9	11.8	85.3
Variety **Aurantiaca**						
form *thembili* ..	5.4	0.2324	—	0.8	9.6	89.6
,, *navasi thembili* ..	5.1	0.2477	—	—	8.6	91.4

The chances of inter-spadix pollination are very remote in the forms *thembili, pumila regia* and *bodiri.* There are slight chances of inter spadix pollination in *navasi thembili* and *gon thembili,* greater chances in the forms *eburnea* and *navasi* and an extremely high chance in *typica, kamandala* and *ran thembili* (the last three forms belonging to the variety **Typica**), parti cularly when the palms are young and vigorous.

Table 5. *Potential for self-pollination*

	Highest	2nd Highest	3rd Highest	Lowest
Length of male phase Length of female phase Potential for self-pollination → Inter-spadix overlap	*regia*	*pumila* *thembili* *navasi thembili*	*eburnea* *kamandala* *ran thembili* *navasi* *gon thembili* and *typica*	*bodiri*
Intra-spadix overlap	*Kamandala* *ran thembili* and *typica*	*eburnea* and *navasi*	*navasi thembili* and *gon thembili*	*thembili*, *pumila regia and* *bodiri*
	regia *pumila thembili* and *navasi thembili*	*ran thembili* *bodiri* *navasi* and *gon thembili*	*eburnea* and *typica*	*kamandala*

There are no significant differences between forms as regards length of male phase

Table 6. *Components of productivity*

Cultivar		*No. of palms*	*No. of bunches/palm*		*No. of flowers/bunch*		*No. of mature nuts/palm/annum*	
			mean	*range*	*mean*	*SE*	*mean*	*range*
Variety form	**Typica**							
	typica ..	10	14.0	12 - 17	44	2.25	61	29 - 77
,,	*kamandala* ..	2	13.5	11 - 14	19	1.08	57	57 - 58
,,	*bodiri* ..	1	17.0	—	146	34.99	63	—
,,	*ran thembili*	2	14.0	11 - 17	26	1.99	48	46 - 50
,,	*navasi* ..	1	17.0	—	116	11.21	63	—
,,	*gon thembili*	6	14.5	12 - 16	12	0.94	44	14 - 77
Variety form	**Nana**							
	eburnea ..	4	19.5	17 - 21	26	0.85	136	83 - 169
,,	*regia* .	4	18.2	18 - 19	24	1.19	106	80 - 129
,,	*pumila* ..	2	9.0	7 - 11	31	4.58	65	45 - 86
Variety form	**Aurantiaca**							
	thembili ..	6	14.2	11 - 18	31	1.34	11	84 - 158
,,	*navasi*	—	—	—	—	—	—	—
,,	*thembili* ..	5	15.6	15 - 17	38	1.83	10	61 - 156

Table 7. *Potential for nut production*

		Highest	2nd Highest	3rd Highest	Lowest
Potential for *nut* production	No. of bunches bunches	*eburnea* *regia*	*bodiri* *navasi*	*thembili* *kamandala* *ran thembili* *navasi* *gon thembili* and *typica*	*pumila*
	No. of female flowers	*bodiri* *navasi*	*typica* *navasi thembili*	*pumila* *thembili*	*eburnea* *regia* *ran thembili* *gon thembili* and *kamandala*
	Harvested nuts/annum	*eburnea*	*thembili* *regia* and *navasi thembili*	*pumila* *bodiri* *navasi* and *typica*	*Kamandala* *ran thembili* and *gon thembili*

Intra-spadix overlap of male and female phases ranges from a few hours to six days with the forms *Kamandala* and *Typica* showing the least likelihood of overlap (Table 5). The forms *thembili* and *navasi thembili* of the variety **Aurantiaca** as well as the forms *pumila* and *regia* of the variety **Nana** show the highest overlap. The forms *typica* and *kamandala* of the variety **Typica** show the lowest overlap (which may extend for a few hours) and self-fertilization as a result of intra-spadix overlap is very remote. Forms *ran thembili, bodiri, navasi* and *gon thembili* (all belonging to the variety **Typica**) are intermediate for this character. Undue emphasis cannot be placed on this observation as only a few palms of these forms have been observed, in some instances just one. The age of the palms and climate may alter the above pattern. The latter factor has been recognised by Whitehead (1965) and also observed by us in the implementation of controlled pollination programmes at this institute during the past 20 years. The potential for self pollination is summarised in Table 7.

Potential for Nut Production

(*a*) *Number of Bunches/year:*

Forms of the variety **Typica** produce on average 11-17 inflorescences per year. The low value of 9 for the form *pumila* palms are known to have a distinct resting period of a few months when no inflorescences are produced, and this may have coincided with the sampling period.

(*b*) *Number of Female Flowers/Bunch:*

The form *bodiri* of the variety *Typica* is a prolific bearer of small nuts (Liyanage 1958), and it produces the highest number of female flowers (146 per inflorescence). Generally the variety **Typica** produces only a few female flowers per bunch (12 - 43) and the figure for the form navasi (115) is perhaps exceptional. The self fertilizing **Nana** and **Aurantiaca** varieties generally produce more female flowers/bunch than the cross-fertilizing **Typica** although this is not so with the material described here.

(*c*) *Number of Mature Nuts/Palm/Year:*

From Table 7 it would appear that from the point of view of the total number of mature nuts harvested per year the form *eburnea* is the best, yielding 135 nuts per year (range 83 - 169). The other self-fertilizing forms, *regia, thembili* and *navasi thembili* yield over a hundred nuts. *Bodiri, navasi* and *Kamandala* are more or less in the same yield group as *typica*, while the forms *gon thembili* and *ran thembili* are poor yielders. Although the form *pumila* of the variety **Nana** has a mean yield of 65 nuts, the pronounced biennial bearing tendency of this form as a result of non production of inflorescences for several months has to be recognised. A mean yield of 50 - 100 nuts over an eight year period has been reported for the form *pumila* (Manthriratna, 1972).

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