

The Morphology and Biology of the Cashew Flower (*Anacardium occidentale* L):

1. FLOWERING HABIT, FLOWERING SEASON, MORPHOLOGY OF FLOWER AND SEX RATIO

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Received for publication February 13, 1963.

Cashew is a tree of considerable economic importance in India, especially on the West Coast. In Kerala, where its cultivation and processing of nuts are largely concentrated, the acreage in 1959-60 was estimated at 1,29,525 with a production of 80,388 tons of raw nuts. The processing industry in Kerala gives employment to about 75,000 persons and the value of cashew kernels and cashew shell liquid exported during 1961 was over 16 crores of rupees. Cashew is mostly grown on barren hill slopes and soils of poor fertility, where no other crop can be profitably cultivated.

In spite of its agricultural, industrial and commercial importance, no attention had been paid until recently on the improvement of this crop. Being a crop in which a high degree of cross pollination occurs in nature, cashew trees exhibit large variations in its economic characters, offering considerable scope for selecting high yielding types from existing population and also for evolving superior varieties by a well-planned programme of hybridization. As a preliminary to the programme of crop improvement, a study of the flowering and fruiting behaviour of the cashew tree was taken up at the Regional Cashewnut Research Station at Kottarakara in Kerala State during the season of 1961-62.

Review of Literature

Studies on certain aspects of floral biology of cashew were undertaken at the fruit. Research Station, Kodur (Andhra) and at the Agricultural Research Station, Taliparamba (Kerala) and these have been reported in the Memoirs of the Department of Agriculture, Madras (1948). Aiyaduri and Koyamu (1957) have reported the results of their studies on variations in 1000 bearing cashew trees of seedling origin. Their study included the flowering season, time of anthesis, sex ratio, fruiting habit and fruit and nut characters. Rao and Vazir Hassan (1957) made preliminary investigations on the various aspects of flowering and fruiting in cashew. Morada (1941) quoted by Rao and Vazir Hassan (1957) has described the cashew flower in detail, besides furnishing elaborate data to bring out the relative size and weight of nut and kernel in relation to the apple.

Materials and Methods

Representative samples were chosen on five year old seedling cashew trees in the station for the various observations made and the data collected are summarised and presented below.

Observations1. *Flowering habit*

Fruit buds in cashew are borne on the past season's growth either terminally or laterally, both vegetative and floral parts emerging from the same bud (Fig. 1). The initial growth that emerges from the growing bud gives rise to normal vegetative leaves, which become smaller and smaller as the extension growth develops into the floral panicle. The inflorescence in cashew are all terminal panicles of the mixed type.

2. *Flowering Season*

The emergence of flower bud extended over a period of nearly five and a half months from 11-9-1961 in different trees. In some trees, the emergence period was continuous, while in some others there were distinct flushes. The period of flower bud emergence in eight trees and the proportion of reproductive shoots in each flush are given in Table I.

TABLE I

Periods of emergence of panicles in different trees

Tree No.	First flush		Flower shoots percent	Second flush		Flower shoots percent	Total
	Date of emergence of First flower bud	Date of emergence of Last flower bud		Date of emergence of First flower bud	Date of emergence of Last flower bud		
2A.	18-11-61	29-12-61	35	4-1-62	24-2-62	50	94
5A.	18-10-61	15-1-62	45	..	..	..	89
14A.	4-10-61	25-10-61	55	..	..	..	22
18	11-10-61	20-10-61	20	..	..	..	10
18A.	11-9-61	20-10-61	20	..	..	..	40
25A.	7-10-61	20-10-61	15	6-1-62	18-2-62	20	58
27	15-10-61	26-10-51	15	8-1-62	22-2-62	20	58
28	2-10-61	27-10-61	25	10-1-62	25-2-62	20	58

It may be seen from the above table that there is considerable variation between trees in the length of the period of emergence of flower buds, as well as, in the pattern of

emergence. While it took only 10 days in a single flush for the completion of bud emergence in tree No. 18, it was extended over a period of 94 days in two flushes in tree No. 2A

Data on flower opening showed that it took 36 days on an average from bud 'burst' to the date of opening of the first flower on the panicle. In most of the panicles the flowers that opened in the early stages were generally staminate, while the perfect flowers made their appearance during the middle of the flowering period of the panicle. Observations made on 47 trees showed that the period of flower opening varied from a minimum of 25 days to a maximum of 168 days. The peak period of flowering in most trees was from December to the middle of February.

3. Morphology of the Flower

The Inflorescence

The cashew inflorescence is a terminal, open panicle, more or less conical in shape, with secondary branches appearing in racemes. The ultimate branch-lets of the panicles, however, are cymes, the terminal bud opening earlier than the lateral buds. The secondary and tertiary branches are subtended by bracts, the older ones being

fairly large and leafy. The main, as well as, the secondary rachis are glabrous and light green in colour, with a reddish tinge in the early stages of emergence of panicles in some trees. The average length of panicles varied from 14.0 cm to 21.4 cm and the average spread at the basal portion varied from 15.6 cm to 27.0 cm. The total number of flowers in a panicle varied from 200 to 1608 the average of 30 panicles (5 panicles each one 6 trees) being 546.

The flower

The cashew tree is polygamous monoecious, with staminate and hermaphrodite flowers appearing on the same panicles. The flowers are small, regular, pentamerous, white or light greenish white in colour at the time of opening, later turning into pink. The structure of the flower is similar in both staminate and hermaphrodite flowers, the pistil being rudimentary or absent in the former. The average measurements of the different floral parts are given in Table II.

TABLE II

Size of flowers and measurements of floral parts

Tree No	Type of flower	Dia. of flower mm	Sepals		Petals		Length of developed stamen mm	No of stamens	Length of style mm
			Length mm	Breadth mm	Length mm	Breadth mm			
8A	Staminate	13.0	4.55	2.15	10.55	2.35	8.80	8.8	-
	Hermaphrodite	16.0	5.25	2.20	12.65	2.85	5.35	8.6	11.2
12	Staminate	10.8	3.55	1.50	10.05	1.70	9.45	8.9	-
	Hermaphrodite	13.9	3.70	2.00	10.20	2.00	5.35	7.0	10.3

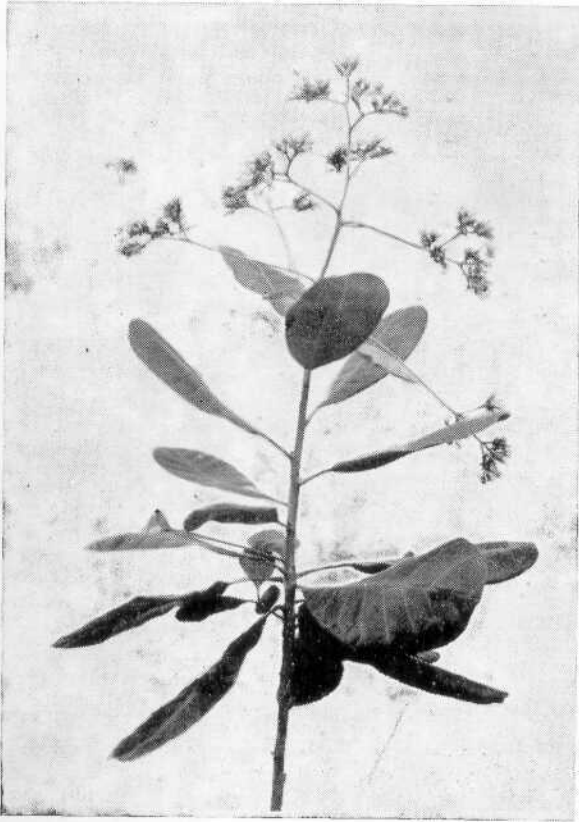


Fig. 1 (a) **Mixed**, terminal inflorescence from a terminal fruit-bud



Fig. 1 (b) **Mixed**, terminal inflorescence from a lateral fruit-bud

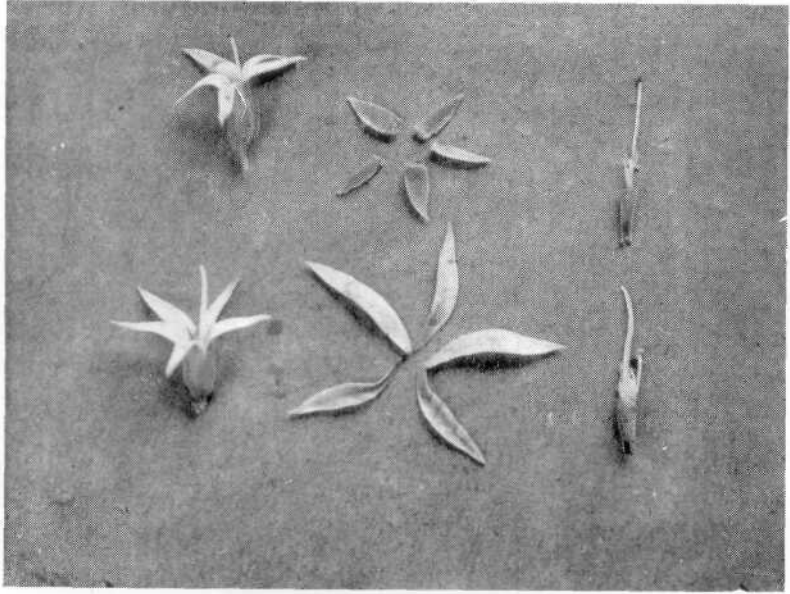


Fig. 2. *Top row:* Staminate flower: Sepals, stamens and staminodes;
Bottom row: Hermaphrodite flower: petals, stamen, staminodes and pistil

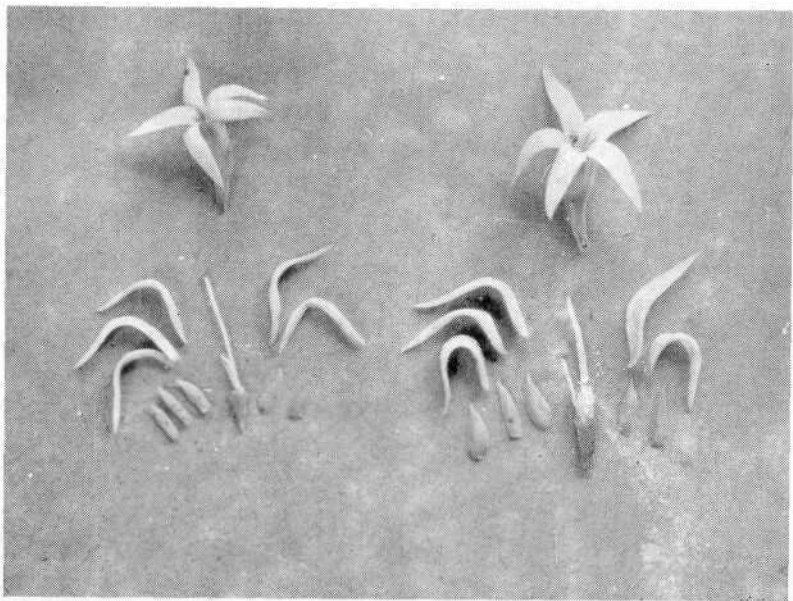


Fig. 3. *Left:* Staminate flower and its parts
Right: Hermaphrodite flower and its parts

It is apparent from the above table that there are slight variations between the mean size of flowers of different trees. On the same tree, the hermaphrodite flowers are bigger than the staminate flowers.

The Calyx

The calyx consists of five free sepals, green in colour, ovate in shape and slightly concave (Fig. 2)

The corolla

There are five free petals, linear to lanceolate in shape and white or creamy white in colour at the time of opening. The petals become recurved within a short time after opening (Fig 3). In some trees, light pink stripes are present on the upper surface of the petals even at the time of opening. In all flowers pink stripes appear a few hours after anthesis and on the following day, these become so pronounced that the whole flower appears to be pink.

The androecium

It consists of one fully developed stamen and 7 - 9 staminodes. The developed stamen has a pink anther with two lobes. In two trees which are introductions from Tanganyika, the colour of the anther is yellowish white. The staminodes have only short filaments and are concealed in the lower half of the open flower. While the developed stamen in the staminate flower has a long filament, rising well above the recurved petals, the corresponding stamen in the hermaphrodite flower is only about half in length of the stamen in the staminate flower and its anther is far below the level of the stigma.

The gynoecium

The ovary is superior, reniform in shape and monocarpelate. The style is thick, tapering towards the end with slightly flattened stigma. In flowers of some trees,

there is a small hook-like curvature of the style, just below the stigma.

4. *Sex ratio*

The proportion of perfect flowers was found to vary considerably even between panicles on the same tree. It was also found that panicles which emerged earlier in the season had a higher proportion of staminate flowers than those produced later in the season. The proportion of perfect flowers produced on 18 trees and the yield of nuts obtained from them during the season 1961-62 are given in Table III.

TABLE III

Proportion of perfect flowers and yield of nuts in trees

Tree No	Mean per- cent of perfect flowers	Gross yield of nuts (kg)
27A	0.45	0.720
19	0.75	0.805
13A	1.4	0.170
18	1.9	0.925
12	2.1	0.986
14A	2.2	2.020
9A	2.1	0.512
15A	5.0	0.605
32	7.6	1.580
11A	7.9	2.030
29	8.6	1.580
28A	11.3	0.420
8A	12.3	1.160
10A	12.8	0.392
7	14.8	1.215
33	19.7	0.190
31A	19.8	1.442
30A	24.9	4.059

Co-efficient of correlation- + 0.39

The data suggest that there is a positive correlation, though weak, between the proportion of perfect flowers and the gross yield of nuts from the tree. However, it has to be mentioned that the trees are very young and the yields of a number of seasons are necessary for confirmation of the above result.

Discussion

Rao and Vazir Hassan (1957) have stated that, unlike in mango, cashew produces its flowers in the current seasons' flushes. Eventhough this may be true when the position of the floral panicle alone is considered, it has to be pointed out that the fruiting pattern in cashew is not basically different from that of mango. Both in mango and in cashew, fruit buds are produced on past seasons' growth; the main difference between the two being that the fruit bud in mango is generally pure (ie. contains floral parts only) while in cashew it is invariably of the mixed type. The earlier phase of growth of the fruit bud in cashew is purely vegetative and it ends in the reproductive phase. In some varieties of mango, a good proportion of fruit buds produced are of the mixed type; but unlike in cashew these mixed buds do not have a purely vegetative phase before producing the panicle. Gardner *et al.* (1952) have classified fruit trees into six main groups based on their fruiting habit. According to them, mango comes under group I having fruit buds terminal and flower buds containing flower parts only and cashew comes under group V having fruit buds lateral and flower buds mixed with terminal inflorescence. Eventhough this classification represents the predominant bearing habits of mango and cashew it has to be pointed out that a high proportion of fruit buds in cashew are terminal.

The fruit bud emergence in cashew extended over a considerable period and in some trees there were two distinct flushes. Generally the earlier flush was the main reproductive flush as observed by Rao and Vazir Hassan (1957). The flowering season also extended over a long period and varied from tree to tree. However, the main season was from December to February, which is in agreement with the observations made by Aiyadurai and Koyamu (1957)

Sex ratio in cashew was found to be influenced considerably by environmental conditions and certain internal factors of individual flowering twigs. However the fact that some of the trees consistently produced a higher proportion of perfect flowers as compared to some others growing under the same environment, suggests that sex ratio is an inherent tree character. Randhawa and Damodaran (1961) have made similar observations in mango.

A comparison of the proportion of perfect flowers and the yield obtained from 18 trees suggests that there is a weak positive correlation between the two factors. However further studies in this respect are needed before any definite conclusion can be drawn.

Summary

Observations were made on the flowering habit, flowering season, morphology of the flower and sex ratio in cashew. Inflorescences were produced terminally on shoots arising from terminal or lateral fruit buds of the mixed type on past seasons' growth. Flower bud emergence commenced by the middle of September and continued till the end of February, the main season being October - November. A study of the morphological features of the flowers in different trees revealed that there were slight

differences in the size of the flowers. On the same tree the perfect flower was larger in size than the staminate flowers. In two trees introduced from Tanganyika, the undehisced anthers of the developed stamens were yellowish white in colour as against the pink colour in others. The proportion of perfect flowers varied from as low as 0.45 percent to 24.9 percent in different trees. A comparison of the sex ratio and the yield of nuts from 28 trees suggested a weak, positive correlation between these characters.

Acknowledgement

The authors express their deep sense of gratitude to Sri. P. C. Sahadevan, Joint Director of Agriculture, Kerala State, for the keen interest he has shown in these investigations and for his valuable suggestions after going through the manuscript. Thanks are also due to the Indian Council of Agricultural Research for their financial assistance for the scheme under which these studies were carried out.

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