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Studies on Floral Biology of Different *Carica* Species

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Abstract: An investigation was carried out to study the floral biology of different *Carica* species. Early flowering was occurred in *C. cauliflora* both male and female flowers after transplanting of the seedlings and male flower emerged earlier compared to female flower of different *Carica* species. The tallest rachis of male inflorescence was obtained from *C. papaya* cv. Shahi. The male flower buds of *C. papaya* cv. Ranchi took the highest time from initiation to dehiscence and the maximum time was required from initiation to receptivity in *C. papaya* cv. Shahi. The anthers dehiscence of all species were increased with the increasing the temperature up to 12 p.m. during the study. The maximum female flower opening was observed in *C. cauliflora* at 8-9 a.m. The opening of flowers Shahi and Ranchi were gradually increased from 6 to 8 a.m. and declined after 8 to 11 a.m. The cent percent fruit set was recorded in *C. cauliflora* on the day of anthesis and the fruit sets were decreased with increasing the anthesis period up to 5 days after anthesis. No fruit set was found at 6 days after anthesis.

Key words: Floral biology, anthesis, stigma receptivity, *Carica* species

INTRODUCTION

Papaya (*Carica papaya* L.) is an important fruit crop of Bangladesh. It is also used as a vegetable at green stage. It is a quick growing fruit, rich in different minerals and vitamins, particularly vitamins A and C. The fruit is available throughout the year. Among the cultivated fruits, it gives the highest production and income per hectare, next to banana[1]. Papaya has great importance for its short growing period, high yield and production of bulky food. The various types of floral, fruit and seed abnormality have been noticed in papaya[2-4]. However, there are some limitations like variation in sex and sex-expression, succeptibility to disease and limitations in vegetative propagation which make it rather unpopular. Hybridization and subsequent selection can make it possible to overcome these problems. The knowledge of flowering behavior is pre-requisite for any planned hybridization programme. It is particularly important in the genus *Carica* where large variation for the sex form exists. Information on floral biology assumes great significance since interspecific hybridization offers possibilities in transferring genes for disease resistance to *C. papaya* cultivars. The present study was therefore, undertaken to study the floral biology of different *Carica* species for successful interspecific hybridization.

MATERIALS AND METHODS

The experiment was conducted at the Horticulture Farm of Bangladesh Agricultural University, Mymensingh during the period of 1999 to 2000. The two cultivated variety viz., *C. papaya* cv. Shahi, Ranchi and *C. cauliflora* a wild but related species of papaya were used to study the floral biology. Monogenic dominant resistant gene to papaya mosaic virus exits in *C. cauliflora*[5]. Uniform plants of *C. papaya* cv. Shahi, Ranchi and *C. cauliflora* were selected during the study. All the trees under the study were given uniform cultural treatments. The male and female flowers were labeled after initiation of flowers during the study. The different stages in the development of flower buds both male and female were labeled when they were just appeared. For systematic study, the whole phase of flower buds of different *Carica* species both male and female were arbitrarily divided into 6 and 8 stages respectively. The stage-I both male and female buds was considered 5 days after initiation and one stage to another stage was considered 3 days interval. The number of anthers dehisced and anthesis of flowers were counted at an interval of an hour from 6 a.m. to 12 p.m. The dehisced anthers were removed to avoid confusion. The receptivity of stigma was studied by fruit set method and controlled pollinations were made for two days before and five days after the opening of the female flowers. Thirty flowers were pollinated under each treatment. The experiment was laid out in complete randomized design with three replication. Data were recorded on days required for first male flower initiation, number of axil at first male flower initiation, length of rachis of male flower inflorescence, number of male flower bud per inflorescence, length of single male flower bud, days required from male flower

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initiation to dehiscence, days required for first female flower initiation, number of axil at first female flower initiation, length of rachis of female flower, no. of female flowers per inflorescence, length of female flower, days required from initiation to receptivity of female flower, percentage of fruit set and percentage of fruit dropped out. Data were statistically analyzed and the means of different parameters were compared by Least significant difference (LSD) test.

RESULTS AND DISCUSSION

Flowering characteristics: There were significant differences among the different *Carica* species in respect of days required for first flower initiation, number of node at which first flower initiation, length of rachis of inflorescence, number of flower buds per inflorescence, length of flower bud, days required for male flower initiation to dehiscence and days required from initiation to receptivity (Table 1). Early flowering was occurred in *C. cauliflora* but delay flowering both male and female noticed in *C. papaya* cv. Ranchi after transplanting of the seedlings. The male flower emerged earlier compared to female flower after transplanting of the seedlings. There was no synchronsation among *Carica* species both male and female flower. However, synchronisation is essential both male and female flowers for successfully interspecific hybridization. This result indicates that planting time could be minimized for obtaining synchronisation among *Carica* species for successfully interspecific hybridization. The duration of flowering both male and female depends on varieties, species, time of planting, age of seedlings, climatic condition. Khuspe and Ugale[6] reported that the inflorescence was emerged 45-48 days after transplanting in *C. papaya* cv. Washington under Maharashtra condition in India. The plants of *C. cauliflora* produced the first male flower at lowest number of node and *C. papaya* cv. Ranchi produced the female flowers at lowest number of node. The plants of *C. papaya* cv. Shahi produced both male and female flowers at the highest number of node. The inflorescence of *C. papaya* cv. Washington was initiated from the axil of 24th leaf incase of male and the axil of 18 to 20th leaf in female flower[6]. The plants of *C. papaya* cv. Shahi gave significantly tallest rachis of male inflorescence and lowest rachis length of male inflorescence was obtained from *C. cauliflora*. The plants of *C. cauliflora* produced the maximum length of rachis of female inflorescence, which was 95% higher than *C. papaya* cv. Ranchi and Shahi. The plants of *C. papaya* cv. Shahi produced the maximum number of male flower buds per inflorescence and minimum number of flower buds was obtained from *C. cauliflora*. The maximum number of female flowers per inflorescence was observed in *C. cauliflora*, which was significantly greater than other *Carica* species and the minimum number of flowers per inflorescence was obtained from *C. papaya* cv. Ranchi which was statistically identical with *C. papaya* cv. Shahi.

The highest length of male flower bud was observed in *C. cauliflora* and the minimum length of flower bud was observed in *C. papaya* cv. Shahi. The highest length of female flower bud was obtained from *C. papaya* cv. Shahi and lowest length was found in *C. cauliflora*. The male flower buds of *C. papaya* cv. Ranchi took the highest time from initiation to dehiscence and shortest time was required for *C. cauliflora*. The maximum time was required from initiation to receptivity in *C. papaya* cv. Shahi followed by Ranchi and lowest time was found in *C. cauliflora*. This might be due to genetical differences among the different *Carica* species.

Development of flower buds: There was a significant difference among the different *Carica* species in respect of flower bud development both male and female flower at all stages (Fig. 1a,b). The maximum growth rate of male flower buds in all stages was observed in *C. cauliflora* and the minimum was found in *C. papaya* cv. Shahi. However, the maximum increasing trend of growth rate was found in stage-II to stage-III among different *Carica* species. The maximum growth rate of female flower buds in all stages was observed in Shahi and the minimum growth rate was noticed in *C. cauliflora*. The increasing trend of growth rate of all *Carica* species was observed upto stage-VII, but the growth rate of flower bud of Shahi and *C. cauliflora* were declined after stage-VII.

Dehiscence of anthers: The maximum anther dehiscence was recorded in *C cauliflora* at 11-12 p.m. but minimum dehiscence was noticed in *C. papaya* cv. Shahi at that time (Table 2). However, the anthers of *C. cauliflora* started dehiscence after 8 a.m. The anthers dehiscence of all species were increased with increasing the temperature up to 12 p.m. during the study. These results revealed that high temperature hastened the dehiscence. Sharma and Bajpay[7] reported that optimum anther dehiscence was 12 to 1 p.m. for papaya. Khuspe and Ugale[6] reported that maximum number of anthers dehisced between 9 a.m. to 12 p.m. in *C. papaya* cv. Washington.

Anthesis of flowers: The maximum female flower opening was recorded in C *cauliflora* at 8-9 a.m but no flowers were opened both *C. papaya* cv. Shahi and Ranchi at 11-12 p.m (Table 3). The anthesis of flowers of Shihi and Ranchi were gradually increased from 6 a.m. to 8 a.m. and declined after 8 a.m. to 11 a.m. The flower of *C. cauliflora* was gradually increased from 6 to 12 p.m. The time of

Table 1: Floral characteristics of male and female flowers of *C. papaya* cv. Shahi, Ranchi and *C. cauliflora*

Treatments		Days required for first flower initiation	No. of node at which first flower initiation	Length of rachis of inflorescence(cm)	No. of flower buds per infloresence	Length of flower bud (cm)	Days required from male flower initiation to dehiscence or anthesis
Male flowers	*C. papaya* cv. Shahi	103.47	24.13	68.47	400.33	2.88	22.80
	C. papaya cv. Ranchi	128.00	19.17	57.73	361.00	2.80	23.00
	C. cauliflora	89.00	18.47	23.00	72.87	3.81	17.80
	$LSD_{(0.01)}$	4.98	2.14	3.22	25.85	0.07	0.40
Female flowers	*C. papaya* cv. Shahi	127.33	27.40	1.92	3.87	5.99	28.47
	C. papaya cv. Ranchi	134.99	21.42	1.86	3.53	5.01	27.07
	C. cauliflora	105.13	22.40	17.67	5.67	4.89	23.67
	$LSD_{(0.01)}$	5.30	4.03	0.89	0.61	0.39	0.44

Table 2: Percentage of anthers dehiscence of *C. papaya* cv. Shahi, Ranchi and *C. cauliflora* at different time

	Percentage of anthers dehiscence					
Treatments	6-7 a.m	7-8 a.m.	8-9 a.m	9-10 a.m	10-11 a.m	11 a.m-12 p.m
C. papaya	1.00	2.00	5.08	11.83	19.00	35.47
C. papaya cv. Rauchi	1.33	4.00	7.00	13.58	21.17	37.17
C. cauliflora	0.00	0.00	5.50	10.97	17.10	55.33
$LSD_{(0.01)}$	0.10	2.47	3.64	6.30	6.38	9.78

Table 3: Percentage of female flower opening of Shahi, Ranchi and *C. cauliflora* at different time

	Percentage of anthers dehiscence					
Treatments	6-7 a.m	7-8 a.m.	8-9 a.m	9-10 a.m	10-11 a.m	11 a.m-12 p.m
C. papaya	11.33	18.33	16.33	7.33	3.00	0.00
C. papaya cv. Rauchi	13.67	22.00	20.00	8.00	3.67	0.00
C. cauliflora	15.33	26.33	29.00	12.33	5.67	2.67
$LSD_{(0.01)}$	5.24	6.22	7.68	5.71	4.16	2.67

Table 4: Effects of stigma receptivity by fruit set methods of *C. papaya* cv. Shahi, Ranchi and *C. cauliflora* during the period of May 2000

Treatments	Fruit set (%)	Dropped out (%)
C. papaya cv. Shahi	51.11	48.89
C. papaya cv. Ranchi	54.44	45.56
C. cauliflora	58.15	41.85
$LSD_{(0.01)}$	4.04	4.04
2 Days before anthesis	28.90	71.11
1 Day before anthesis	72.22	27.78
At the time of anthesis	96.67	3.33
1 Day after anthesis	92.22	7.78
2 Days after anthesis	67.67	23.33
3 Days after anthesis	58.89	41.11
4 Days after anthesis	42.22	57.78
5 Days after anthesis	23.33	76.67
6 Days after anthesis	0.00	100.00
$LSD_{(0.01)}$	7.00	7.00

Table 5: Combined effects of stigma receptivity by fruit set methods of *C. papaya* cv. Shahi, Ranchi and *C. cauliflora* during the period of May 2000

Treatments		Fruit set (%)	Dropped out (%)
	2 Days before anthesis	23.33	76.67
	1 Day before anthesis	66.67	33.33
	At the time of anthesis	93.33	6.67
C. papaya cv.	1 Days after anthesis	86.67	13.33
Shahi	2 Days after anthesis	76.67	23.33
	3 Days after anthesis	56.67	43.33
	4 Days after anthesis	36.67	63.33
	5 Days after anthesis	20.00	80.00
	6 Days after anthesis	0.00	100.00
	2 Days before anthesis	26.67	73.33
	1 Days before anthesis	73.33	26.67
	At the time of anthesis	96.67	3.33
C. papaya cv.	1 Day after anthesis	93.33	6.67
Ranchi	2 Days after anthesis	76.67	23.33
	3 Days after anthesis	56.67	43.33
	4 Days after anthesis	43.33	56.67
	5 Days after anthesis	23.33	76.67
	6 Days after anthesis	0.00	100.00
	2 Days before anthesis	36.67	63.33
	1 Day before anthesis	76.67	23.33
	At the time of anthesis	100.00	0.00
	1 Days after anthesis	96.67	3.33
C. cauliflora	2 Days after anthesis	76.67	23.33
	3 Days after anthesis	63.33	36.67
	4 Days after anthesis	46.67	53.33
	5 Days after anthesis	26.67	73.33
	6 Days after anthesis	0.00	100.00
$LSD_{(0.01)}$		12.12	12.12

anthesis could be due to environmental difference as well as interaction of genotype and environment. Similar observations have been made by Makako and Nakasone[8], Subramanyan and Iyer[9], Khuspe and Ugale[6].

Stigma receptivity: There was a significant difference in respect of stigma receptivity by fruit set method of *C. papaya* cv. Shahi, Ranchi and *C. cauliflora* (Table 4). The maximum fruits were recorded in *C. cauliflora*. The fruit sets were decreased with increasing the anthesis

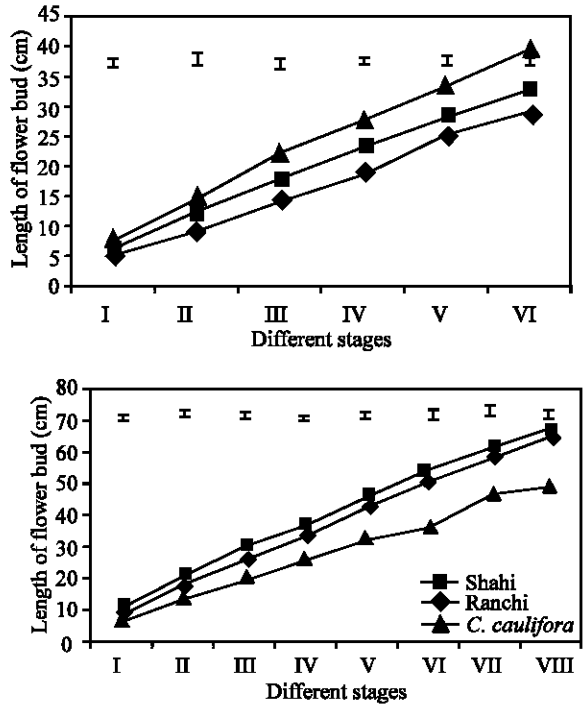

Fig. 1: Growth and development of a) male and b) female flower buds of different Carica species at different stages

up to 5 days after anthesis. Significantly highest number of fruit set was recorded on the day of anthesis. No fruit set was found at 6 days after anthesis. However, some receptivity was attained by stigmas two days before anthesis. This results indicated that the stigmas began to attain receptivity 2 days before anthesis and continued up to 5 days after anthesis. The interaction effect of different *Carica* species and duration of pollination showed the highly nonsignificant in respect of fruit set (Table 5). The cent percent fruit set was recorded in *C. cauliflora* on the day of anthesis followed by *C. papaya* cv. Ranchi. But it began to decline gradually upto 5 days after anthesis in all the species. No fruit set was found in all species at 6 days after anthesis and stigmas became dried and black in colour. According to Sharma and Bajpai [7] the receptivity of stigma started 2 days before anthesis and continued up to 3 days after anthesis in *C. papaya*. Similar observations have also been reported by Subramanyam and Iyer [9], Khuspe and Ugale [6].

From the results of present study, it may be concluded that male and female flowers of *C. cauliflora* appeared earlier than others *Carica* species and maximum stigma receptivity was found on the day of anthesis. However, planting time could be minimized for obtaining synchronization among the *Carica* species for successfully interspecific hybridization.

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