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Studies on floral biology of seven litchi (*Litchi chinensis* Sonn.) cultivars

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ABSTRACT

Floral biology of seven litchi cultivars (China, Deshi, Elaichi, Kasba, McLean, Nafarpal and Piazi) was studied. Cultivar Deshi showed panicle formation on 2nd January, while panicle initiation was early (10th February) in cv. Piazi. Flowering duration varied between 13±4 days in 'China' and 30± 3 days in 'Piazi'. Male:hermaphrodite flower ratio was maximum in 'Piazi' (5.8:1) and minimum in 'China' (2.74:1). In general, anthesis was maximum between 7 and 8 AM, while, anther dehiscence was maximum between 9 and 10 AM. Percentage of viable pollen varied between 82.14% in cv. Elaichi and 91.38% in cv. Piazi Pollen germination was higher in 15% sucrose solution.

Key words: Litchi, anthesis, dehiscence, pollen viability, flowering.

INTRODUCTION

Litchi is one of the most important subtropical fruit crops of the family Sapindaceae. Area under litchi, both in India and other litchi growing countries of the world is increasing rapidly owing to the fruit's popularity globally. In view of the importance of litchi in West Bengal, efforts are being made to provide technological support through research for increasing production, post-harvest management and marketing. However, until now, not much attention has been paid to varietal improvement. Very little information is available on flowering habit and floral biology of litchi, factors that are important for varietal improvement. Keeping this in view, the present investigation was undertaken for studying floral biology of seven litchi cultivars.

MATERIAL AND METHODS

The present investigation was conducted using 25 year-old litchi plants of cvs. China, Deshi, Elaichi, Kasba, McLean, Nafarpal and Piazi, grown at Horticultural Research Station, Mondouri, B.C.K.V., West Bengal. Ten panicles were tagged at random in each variety, covering all the directions in a plant, and three plants were earmarked in each cultivar to study floral biology. Observation on anthesis was recorded from 7 AM to 6 PM at regular intervals for seven days. Anther dehiscence was studied by marking 20 anthers at 8 AM and these were observed every hour upto 6 PM for 3 days. Data on percentage of viability and size of pollen were recorded using acetocarmine stain. Percentage of pollen germination was recorded by culturing pollen in different concentrations (0, 5, 10, 15, 20, 25, 30 and 35%) of sucrose solution at room temperature for 24 hours.

RESULTS AND DISCUSSION

Panicle initiation was seen between 2nd January and 24th February in all the seven cultivars studied. Among these, cv. Deshi was the earliest to produce panicles (2nd January), followed by McLean (7th January). Cv. China was the last to flowe (31st January). Completion of panicle initiation was earliest (10th February) in cv. Piazi, followed by cv. Deshi (12th February) and 25th February in cv. Nafarpal. Duration of panicle initiation was shortest (25±0 days) in va. Elaichi, followed by cv. China (25±2 days), whereas, cvs. Deshi and McLean took maximum number of days (42±4 and 41.5±5.5 days, respectively) to complete panicle initiation. It is clear from these data that when panicles initiated early in the season, longer duration was needed to complete their emergence, while, cultivars that started panicle initiation late in the season, took shorter time. This may be due to low temperatures prevalent during the early phase of panicle initiation, and, with increase in temperature, duration of panicle initiation shortened.

In litchi, flowers that open first are usually male, followed by hermaphrodite and pseudohermaphrodite flowers. In the present study, first flower opening was noted on 18th February in cv. Piazi, followed by that on 22nd and

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Table 1. Flowering behaviour in different litchi cultivars

Cultivar	Date of panicle initiation	End of panicle initiation	Duration of panicle initiation (days)	Date of first male flower opening	End of male phase	Duration of male phase (days)	Date of first herma-phrodite flower opening	End of herma-phrodite phase	Duration of herma-phrodite phase (days)	Date of first pseudo-herma-phrodite flower opening	End of pseudo-herma-phrodite phase	Duration of pseudo-herma-phrodite phase (days)	Total flowering duration (days)
China	31st Jan.	24th Feb.	25.0± 2	7th March	9th March	4.0± 1	9th March	13th March	5.5±1.5	12th March	19th March	7.5±0.5	13.0±4.0
Deshi	2nd Jan.	12th Feb.	42.0± 4	22nd Feb.	22nd March	16.0± 4	8th March	15th March	7.0±1.0	13th March	19th March	7.5±0.5	27.0±4.0
Elaichi	28th Jan.	21st Feb.	25.0± 0	1st March	14th March	12.5± 1.5	13th March	16th March	4.0±0.0	16th March	24th March	7.5±1.5	24.0±2.0
Kasba	24th Jan.	22nd Feb.	30.5± 1.5	4th March	15th March	10.0± 2	12th March	19th March	6.5±1.5	17th March	23rd March	7.0±1.0	20.5±2.5
McLean	7th Jan.	16th Feb.	41.5± 5.5	23rd Feb.	12th March	15.5± 3.5	8th March	14th March	6.0±1.0	13th March	20th March	8.0±1.0	26.5±2.5
Nafarpal	19th Jan.	25th Feb.	38.0± 2	4th March	18th March	13.0± 2	15th March	22nd March	7.0±2.0	21st March	27th March	7.0±1.0	24.0±3.0
Piazi	9th Jan.	10th Feb.	33.0± 3	18th Feb.	9th March	16.0± 4	7th March	14th March	5.5±2.5	12th March	18th March	6.0±2.0	30.0±3.0

Table 2. Floral characters in different litchi cultivars

Cultivar	No. of male flowers/ panicle	No. of hermaphrodite flowers/ panicle	No. of pseudo-hermaphrodite flowers/ panicle	Sex Ratio (male : hermaphrodite)	Per cent hermaphrodite flowers	Flower size		No. of stamens / flower	Colour of disc	Colour of panicle
						Length (mm)	Diameter (mm)			
China	112.67	196.33	425.00	2.74:1	26.74 (31.13)	7.17	7.12	6.33	Light cream	Yellowish green
Deshi	446.50	257.00	640.67	4.23:1	19.17 (25.95)	4.07	5.00	7.00	Light cream	Light green
Elaichi	297.33	203.25	624.33	4.54:1	18.06 (25.14)	5.83	6.67	7.33	Light yellow	Green
Kasba	326.00	222.00	7.05.67	4.64:1	17.72 (24.89)	6.40	7.95	6.25	Light cream	Green
McLean	598.75	284.25	459.33	3.72:1	21.18 (27.39)	5.00	5.55	7.25	Light yellow	Light green to green
Nafarpal	269.67	173.33	361.67	3.64:1	21.54 (27.63)	6.83	7.33	6.50	Light cream	Light green
Piazi	589.67	222.33	700.00	5.80:1	14.69 (22.51)	4.83	5.62	6.40	Light cream	Green
SEm ±	24.262	8.142	15.1988	-	0.335	0.441	0.081	NS	-	-
CD (*P=0.05*)	74.788	25.098	46.85	-	1.033	1.360	0.248	-	-	-

NS=Non-significant

Table 3. Percentage anthesis at different times of the day in various litchi cultivars

Cultivar	Before 7 AM	7 - 8 AM	8 -10 AM	10 -12 AM	12 - 2 PM	2 - 4 PM	4 - 6 PM
China	48.15	12.96	18.52	14.81	3.70	-	1.85
	(43.94)	(21.08)	(25.49)	(22.63)	(11.06)		(7.82)
Deshi	42.86	9.52	28.57	9.52	9.52	-	-
	(40.89)	(17.95)	(32.31)	(17.97)	(17.97)		
Elaichi	37.50	12.50	18.75	18.75	6.25	-	6.25
	(37.76)	(20.69)	(25.66)	(25.66)	(14.48)		(14.48)
Kasba	39.28	10.71	21.43	14.29	7.14	3.57	3.57
	(38.81)	(19.10)	(27.58)	(22.21)	(15.50)	(10.89)	(10.89)
McLean	55.00	10.00	17.50	10.00	2.50	-	5.00
	(47.87)	(18.43)	(24.73)	(18.43)	(9.09)		(12.92)
Nafarpal	40.00	11.43	25.71	14.29	8.57	-	-
	(39.23)	(19.76)	(30.47)	(22.21)	(17.02)		
Piazi	52.78	2.78	25.00	13.89	5.56	-	-
	(46.59)	(9.59)	(29.99)	(21.88)	(13.63)		
SEm ±	0.456	0.484	0.336	0.208	0.326	-	-
CD (*P=0.05*)	1.406	1.491	1.036	0.642	1.005	-	-

23rd February in cvs. Deshi and McLean, respectively, while it was on 7th March in cv. China. The first phase concluded by 9th March in cvs. China and Piazi, but was 15th March in cv. Nafarpal. Duration of the first phase (male phase) lasted only 4±1 days in cv. China, and 16±4 days in cvs. Deshi and Piazi. The second phase, i.e., hermaphrodite phase, was found to overlap slightly with the first phase. Hermaphrodite flowers started opening by 7th March in cv. Piazi, and were noted to open last in cv. Nafarpal (15th March). Hermaphrodite-flower opening ended early in cv. China (13th March), and on 22nd March in cv. Nafarpal. Duration of the second phase of flowering varied between 4±0 days in cv. Elaichi and 7±2 days in cv. Nafarpal. The last phase, i.e., pseudohermaphrodite phase, started one to two days, before or just after completion, of the second phase. Among the cultivars studied, pseudohermaphrodite phase was earlier (between 12th March and 18th - 19th March) in cvs. China and Piazi and continued until 21st to 27th March in cv. Nafarpal. Duration of this phase varied between 6±2 days in cv. Piazi and 8±1 days in cv. McLean. In general, the first phase of flowering (male phase) was the longest of the three phases and took up almost 40-50% of the total flowering duration, followed by the third phase (pseudohermaphrodite phase). Similar observations were also reported by Chadha and Rajpoot (1969) and Stern and Gazit (1996). Total flowering duration in litchi varied between (as low as) 13±4 days in cv. China, to 30±3 days in cv. Piazi. Results showed that cultivars that start flowering early in the season take longer to complete flowering cycle, whereas, those that start flowering later in the season, take a shorter time to complete flowering. This may be due to increase in temperature during later part of the season. It was also observed that if the panicle starts flowering too late in the season, it may skip the first phase or the first phase may last one to two days; the second phase of flowering started immediately thereafter. Length of the flowering cycle varies with the genotype and weather, and, is much shorter under warm temperatures (Stern and Gazit, 2003).

Table 4. Anther dehiscence at different times of the day (based on 20 flowers tagged at 8 AM)

Cultivar	9-10 AM	10-11 AM	11-12 AM	12-1 PM	1-2 PM	2-3 PM	3-4 PM	4-5 PM	5-6 PM
China	6	5	3	1	-	-	1	1	-
Deshi	8	5	4	1	1	-	-	1	-
Elaichi	5	5	2	-	2	-	1	-	1
Kasba	10	5	3	-	-	1	-	-	-
McLean	9	3	4	2	2	-	1	-	-
Nafarpal	6	4	4	1	-	-	-	1	-
Piazi	8	4	5	-	2	1	-	-	-
SEm ±	0.504	NS	NS	NS	NS	-	-	-	-
CD (*P=0.05*)	1.553	-	-	-	-	-	-	-	-

NS=Non-significant

Number of male flowers was maximum (598.75/ panicle) in cv. McLean, followed by cv. Piazi (589.67/ panicle), compared to 112.67/panicle in cv. China. Number of hermaphrodite flowers per panicle was also found to be maximum (284.25) in cv. McLean, and only 173.33/ panicle in cv. Nafarpal. Number of pseudohermaphrodite flowers per panicle varied between 361.67 in cv. Nafarpal and 705.67 in cv. Kasba. Average percentage of pseudohermaphrodite flowers per panicle was higher, followed by male flowers, in all the varieties studied except cv. China (which showed higher number of hermaphrodite flowers than male flowers). Sex ratio (male:hermaphrodite) of flowers varied between 2.74:1 in cv. China and 5.8:1 in cv. Piazi. Similar observation was also recorded by Sarkar and Bondopadhyay (1989).

Average (of three types) flower size was found to be largest in cv. China (7.17mm x 7.12mm), and was smallest in cv. Deshi (4.07mm x 5.00mm). Maximum length (7.17mm) and diameter (7.95 mm) of flower was noted in cvs. China and Kasba, respectively. This result is similar to the report of Menzel *et al* (2002). In general, flower diameter was slightly higher than flower length, except in cv. China.

Average number of stamens in each flower varied between 6.25 (cv. Kasba) and 7.33 (cv. Elaichi). Active stigma of the hermaphrodite flowers was generally bi-lobed, with two ovules on the base; but, tri- and tetra-lobed stigma, with respective number of ovules on the base were also noted in almost all the cultivars under study. Length of stigma and stamens varied with type of flower. Male flowers had well-developed and longest stamens in while female parts (ovary and stigma) were very poorly/not developed. Shortest stamens were seen in hermaphrodite flowers and rarely exceeded length of the ovule, but, both stigma and ovary were well developed here. Pseudohermaphrodite flowers were somewhat similar to male flowers in respect of stamen development, and functioned as male; development of ovary and stigma in this type of flowers was superior to that in the male but not well-enough as in hermaphrodite flowers, to set fruit. Floral disc in cvs. Elaichi and McLean was light-yellow in colour, while, rest of the varieties had light-cream coloured floral disc. Colour of the flower panicle was green in cvs. Elaichi, Kasba and Piazi, light-green in cvs. Nafarpal and Deshi, light-green to green in cv. McLean, and yellowish-green in cv. China.

Table 5. Pollen viability and pollen size in various litchi cultivars

Cultivar	Percentage of viable pollen usingacetocarmine test	Size of pollen	
		Length (µ)	Diameter (µ)
China	90.20 (71.76)	31.25	31.00
Deshi	89.36 (70.96)	32.50	32.50
Elaichi	82.14 (65.00)	30.57	29.50
Kasba	82.15 (65.01)	36.80	32.28
McLean	90.78 (72.36)	39.86	39.00
Nafarpal	83.33 (65.99)	36.09	34.00
Piazi	91.38 (72.99)	37.86	30.86
SEm ±	0.536	0.225	0.148
CD (*P=0.05*)	1.653	0.693	0.456

Observation on anthesis was recorded from 7 AM to 6 PM. Maximum percentage of anthesis was seen between 7 AM and 8 AM in cvs. Elaichi, Kasba, McLean and China; and between 8 AM and 10 AM in vars. Nafarpal, Deshi and Piazi, and gradually slowed down thereafter. However, mejority of the anthesis was noted before 7 AM in all the cultivars under study. This indicates that anthesis continues throughout the night and the following day (Chadha and Rajpoot, 1969). Anther dehiscence was highest in the mornings between 9 AM and 10AM (Chadha and Rajpoot, 1969). After 12 Noon, it slowed down drastically.

Percentage of viable pollen varied between 82.14 in var. Elaichi and 91.38 in cv. Piazi. Other varieties fell in this range. Size of pollen was largest (39.86µ x 39.00µ) in cv. McLean, compared to 30.57µ x 29.50µ in cv. Elaichi.

Table 6. Pollen germination percentage in different concentrations of sucrose solution

Cultivar	Concentration of sucrose solution (%)							
	0	5	10	15	20	25	30	35
China	8.33 (16.77)	13.79 (21.79)	19.05 (25.88)	58.06 (49.66)	43.33 (41.17)	20.69 (27.05)	15.00 (22.79)	0.00 (4.05)
Deshi	4.00 (11.54)	10.34 (18.75)	28.21 (32.08)	47.17 (43.37)	29.17 (32.68)	12.28 (18.68)	10.26 (18.68)	0.00 (4.05)
Elaichi	11.76 (20.05)	20.00 (26.56)	28.57 (32.31)	55.88 (48.38)	37.15 (37.55)	18.18 (24.25)	8.00 (16.43)	7.41 (15.56)
Kasba	11.11 (19.45)	18.75 (25.66)	26.09 (30.72)	53.84 (47.20)	35.71 (36.69)	13.13 (21.24)	7.64 (16.04)	3.45 (10.63)
McLean	10.00 (18.42)	14.89 (22.69)	21.62 (27.71)	51.11 (45.64)	31.58 (34.19)	13.51 (21.56)	7.14 (15.50)	4.44 (12.10)
Nafarpal	4.54 (12.24)	11.11 (19.47)	29.51 (32.90)	42.31 (40.58)	46.15 (42.79)	21.74 (27.79)	6.45 (14.71)	2.00 (7.95)
Piazi	6.12 (14.32)	8.93 (17.38)	20.83 (27.15)	56.82 (48.92)	42.86 (40.89)	8.47 (16.92)	4.26 (11.89)	2.78 (9.58)
SEm ±	0.538	0.304	0.361	1.208	0.477	0.400	0.203	1.099
CD *(P=0.05)*	1.659	0.938	1.113	3.725	1.469	1.233	0.625	3.387

Overall pollen germination was maximum in 15% sucrose solution, except in cv. Nafarpal, which showed maximum pollen germination in 20% sucrose solution (Shukla *et al*, 1978). Among the cultivars studied, 'China' showed maximum (58.06%) pollen germination in 15% sucrose solution, followed by 56.82% in cv. Piazi.

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