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STUDIES ON THE FLORAL BIOLOGY OF JACKFRUIT (*Artocarpus heterophyllus* Lam.)

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ABSTRACT

The experiment was carried out with the aim to study floral biology of jackfruit using 10 jackfruit genotypes at AICRP on Fruits, BCKV, Mondouri, West Bengal (India). Floral buds since initiation were continuously observed for a set of parameters. Bud development in jackfruit took 28-46 days while successive spike openings took 8–36 days and spikes opening to spathe shedding 8-16 days. In male spike opening to anthesis ranged from 16 to 32 days and anther sacs availability for 3-7 days. In female spikes, stigmas were available from 12-34 days and receptive from 5th to 34th days after emergence. Female spike length ranged from 4.65 to 9.80 cm and diameter from 3.18 to 5.90 cm. Sex ratio was highest in December. Male spike length was 3.8-10.9 cm and diameter 1.60-3.78 cm. Number of individual flowers spike^{-1} was 3565-9831 for female and 2736-1294 for male. The study revealed that genotypes 10/9, 11/6, 11/9 and 11/10 can be used for future crop improvement based on reproductive traits of male and female parents that ultimately indicates the quality and yield potential of those individuals.

Key words: Floral biology, jackfruit, sex ratio, spikes, stigma receptivity

INTRODUCTION

Jackfruit (*Artocarpus heterophyllus* Lam.), belonging to the family (Moraceae), is known as "Poor man's food" and thought to have originated in evergreen rain forests of Western Ghats of India in places at elevation of 400-1200 m amsl (Haq, 2006). The jackfruit is a multi-purpose plant species and provides food, timber, fuel, fodder, medicinal and industrial products. The primary economic product is fruit which is used both as mature and immature. The fruit is rich in carbohydrates, proteins, potassium, calcium, iron and vitamin A, B & C, while the presence of isoflavones, antioxidants and phytonutrients in fruits indicates that jackfruit has anti-cancerous properties (APAARI, 2012). In spite of such a vast potential and usefulness, jackfruit has remained an underutilized fruit species and more scientific research is needed to exploit it as a commercial crop. Worldwide, the major jackfruit producing countries are Bangladesh, India, Myanmar, Thailand, Vietnam, Philippines, Indonesia, China, Malaysia and Sri Lanka (Haq, 2006). In India jackfruit occupied an area of 1.5 lakh ha in the year 2015-2016 with production potential of 17 lakh metric tonnes (Anon, 2017). West Bengal state shares 11.36% of the total area under the crop with production of 1.97 lakh metric tonnes (Anon, 2017).

A thorough knowledge on floral biology with its phenological events is the foremost important factor to initiate any crop improvement program. In jackfruit scientific information on floral biology is scanty and very less is known about the breeding procedure of jackfruit (Azad, 2007). The minimal

information whatever available show high variation (Haque, 2001). The flower bud development takes on an average 59.4 and 14.9 days for successive spikes opening as reported Haque (2001) while Mannan *et al*. (2006) found it to be 36.8 days for flower bud development and 20.46 days between two successive spike openings. Sambamurty and Ramalingam (1954) have suggested the receptivity of stigmas for only 36 h while Moncur (1985) suggested two weeks duration of stigmatic receptivity. Therefore, to reduce the ambiguity existing in current knowledge regarding jackfruit floral biology, the present study was aimed to gather information on the phenological events in floral development of jackfruit that could be utilized in plant improvement program for screening and improving the existing genotypes.

MATERIALS AND METHODS

The present experiment was conducted at Research Station of AICRP on Fruits, BCKV, Mondouri, West Bengal (India) from December 2014 to March 2015. The farm was situated at 23.5° N latitude and 80° E longitude at an altitude of 9.75 m amsl. The land was new alluvial and soil clay loam in texture. The average mean temperature, as per the information procured from the Department of Agriculture Meteorology & Physics, BCKV, Mohanpur, West Bengal, during December (2014), January, February and March (2015) was 18.07, 18.07, 21.74 and 25.49°C, respectively, whereas the relative humidity during these months was 98.1, 93.6, 96.3 and 87.9%. The rainfall and sunshine during these respective months was 0, 1.2, 7.2 and 21.2 mm and 6.3, 7.0, 8.2 and 9.3 h, respectively.

Ten jackfruit genotypes *viz*., genotype-9/7, genotype-9/8, genotype-10/4, genotype-10/6, genotype-10/9, genotype-10/10, genotype-11/6, genotype-11/7, genotype-11/9 and genotype-11/10 were continuously monitored during December 2014 to March 2015. Phenological events (days required for floral bud development, period from initiation of spike opening to shedding of spathe, the time required between two successive spike openings, the sequence of spike opening on footstalk, duration between male spike opening and anthesis, duration of availability of pollen grains on male spike, duration between female spike opening and protrusion of stigma) of five randomly selected floral buds from each genotype were recorded by daily observation of tagged buds. To study duration of receptivity of stigmas on female spike female inflorescences were tagged and hand pollinated from 5^{th} day of stigma emergence to 34^{th} day after stigma emergence. Five spikes per stigmal stages, with a total of 150 spikes, were cross-pollinated. On the day of stipule opening, female inflorescences were covered with paper bags and crossings done following the controlled pollination (Frampton, 1997). For morphology of male and female inflorescences, the developmental phases were assessed each day using a hand-held magnifier (10x). At maximum receptivity or pollen-release stage, the morphological characters i.e. colour of inflorescences, stigma and anthers, length and width of inflorescences, of receptive female and pollen-releasing male inflorescence were observed visually and measured using Vernier calliper. The number of stamens male^{-1} inflorescence was calculated by observing randomly selected 1 cm^2 patch of each inflorescence (using a hand-held magnifier) and multiplying by the total surface area of inflorescence at maximum receptive stage. The total surface area of male inflorescences was calculated by using the formula for surface area of a cylinder (area = 2 π.r.l, where 'r' and 'l' represent the radius and length of inflorescence, respectively). As the spine of rind of syncarp is formed from the tip of perianth (the stigmatic protrusion), it was presumed that each spine of syncarp developed from a single flower with a single functional ovule. The data for the number of ovules inflorescence^{-1} was obtained by counting the number of spines syncarp^{-1} (Pushpakumara, 2006). Five randomly selected floral buds (either male or female) were tagged at the initiation stage for each aspect and observed each day. Sex ratio between male and female was calculated as under:

$$\text{Sex ratio} = \frac{\text{Total number of male spikes tree}^{-1}}{\text{Total number of female spikes tree}^{-1}}$$

The data analysis was done by calculating range, mean and standard deviation following Panse, and Sukhatme (1985).

To study the pollen viability and germination, pollens were collected from 1st to 6th day of full coverage flowers on male spikes. Pollens were assessed for viability test after staining with 1% aceto-carmine (Nassar *et al.*, 2000). Pollen germination was observed with 10% sucrose solution + 1% agar through hanging drop technique (Shivanna and Rangaswamy, 1992). The statistical analysis of data regarding pollen viability and pollen germination were done following complete randomized design as per Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Phenology of flowering

Days required for floral bud development in present study ranged from 28 (genotypes 10/6 and 10/9) to 46 (genotype 11/7) with a mean of 34.36 (Table 1). Sinha (1975) found that an average of 41 days was required for the development of spike from a tiny bud. Haque (2001) observed that the time required for floral bud development in jackfruit ranged from 51 to 75 days with an average of 59.4 days. These were quite longer period than the present finding. In an off-season experiment on jackfruit Mannan *et al.* (2006) reported that the period for floral bud development took 33 to 42 days with an average of 36.8 days which is in agreement with our findings. The variability observed may be due to environmental and genotypic differences.

Table 1: Days required for floral bud development

Genotype No.	Range (days)	Mean±SD
9/7	30-34	31.67±2.08
9/8	31-39	35.00±4.00
10/4	32-41	36.33±4.51
10/6	28-36	31.33±4.16
10/9	28-39	32.67±5.69
10/10	31-39	36.00±4.36
11/6	30-34	32.33±2.08
11/7	34-46	39.33±6.11
11/9	32-40	36.00±4.00
11/10	29-36	32.33±3.51
Average	-	34.30±4.05

Sequence of flowering in footstalk showed 18 different types of sequences in the genotypes studied (Table 2). Genotypes 10/6, 10/10 and 11/6 showed one

Table 2: Sequence of flower opening in footstalk

S. No.	Sequences of flower opening	Genotype number
1)	Male only	10/10
2)	Male-male-female-female	10/10, 11/6,11/10
3)	Male-male-female-female-male	9/8, 10/4
4)	Male-male-female-male	10/6
5)	Male-male-female	9/8, 10/6
6)	Female only	11/9, 11/10
7)	Male-female-female	10/10, 11/7
8)	Male-female-female-female	9/8, 11/6, 11/9
9)	Male-female-female-male-male	10/6, 11/7
10)	Female-female-female-male	9/7
11)	Female-female-female-male-female	11/9
12)	Female-male-female-male-male-female	10/9, 11/7
13)	Female-male-female-female-male-female	10/4, 11/9
14)	Female-male-female-male-female-female-male-female-female	10/9, 11/10
15)	Female-male-male	11/6
16)	Male-female-male-female-male	9/7
17)	Female-female-male-female-female-male-male	9/7, 10/9
18)	Male-male-male-female-male-male-male-male-female-male-male-male-male-male-male-female-female-male	10/4

new sequence, genotypes 9/8 and 11/10 showed 2 new sequences, genotypes 9/7, 10/4, 10/9 and 11/7 showed 3 new sequences and lastly genotype 11/9 showed 4 new sequences. Among these the longest sequences was observed in genotype 10/4 only. This aspect differed with all other findings. Haque (2001) observed that a footstalk may bear one or more spikes only male or both male and female emerging in 6 different sequences i.e. male spikes; male-male-female-female; male-male-female-male-female-male; male-male-male-female-male; female-male-male; female-male-male-male and female-male-male-female-male. Samad (2005) found that foot-stalks bear the following sequences, i) male only ii) male-male-female-male iii) male-male-female-male-female-male iv) female-male-male-male; v) female-male-male-female-male. Mannan *et al.* (2006) reported that a footstalk may bear one or more spikes emerging in a certain sequence as i) male spikes; ii) male-male-female; iii) male-male-female-female; iv) male-male-female-male-female-male; v) male-female-male-female, and vi) female-male-male-female-male. In present study many new sequences were observed i.e. male-male-female-female-male; male-female-female; male-female-female-female; male-female-female-male-male; female only; female-female-female-male; female-female-female-male-female; female-male-female-male-male-female; female-male-female-female-male-female; female-male-female-male-female-female-male-female-female and male-male-male-female-male-male-male-male-male-female-male-male-male-male-male-male-male-female-female-male; though some sequences were found similar to the above findings. These differences indicate environmental influences or heterozygous nature of jackfruit played the key role in it.

Two successive spikes opening took 8 (genotype 10/9) to 36 (genotype 10/6) days with an average of 23.6 days (Table 3). Haque (2001) reported that time required between two successive spike opening took 10-22 days (average 14.9 days). There was quite variation in timing and sequence of emergence of both male and female spikes from plant to plant. Samaddar (1990) found that the period for next opening was 9.5 to 15.5 days (average 12.5 days). The result of present experiment differed with the above findings. On the other hand, an experiment on off-season flowering of jackfruit resulted both male and female spikes that took 15 to 25 days (average 20.46 days) between two successive spike openings (Mannan *et al.*, 2006). This was in agreement with the present finding.

Spike opening to shedding of spathe took an average 11.2 days with a range of 8 days (genotypes 9/7, 10/6, 10/9, 10/10 and 11/6) to 16 days (genotypes 11/9 and 11/10) (Table 3). The results were in agreement with Alexander *et al. (*1983) who reported that both male and female spike took 7-18 days (average 11.98 days) from initiation of spike opening to shedding of spathe. However, the result a little varied from Azad (1989) and Haque (2001) who reported that both male and female spikes took 4.5 to 6.3 days (average 5.4 days) and 6-14 days (average 9.3 days), respectively, from initiation of spikes opening to shedding of spathe. These differences may be attributed to the variation in climatic conditions and heterozygous nature jackfruit.

Table 3: Time required between two successive spike openings and period from initiation of spike opening to shedding of spathe

Genotype No.	Two successive spike openings		Initiation of spike opening to shedding of spathe	
	Range (days)	Mean ± SD	Range (days)	Mean ± SD
9/7	21-26	23.00±2.65	8-13	11.00±2.65
9/8	19-28	23.67±4.51	9-10	9.67±0.58
10/4	23-28	26.00±2.65	9-13	10.67±2.08
10/6	28-36	31.33±4.16	8-16	11.00±4.36
10/9	8-19	14.33±5.69	8-12	9.67±2.08
10/10	22-25	23.33±1.53	8-12	10.33±2.08
11/6	20-27	23.67±3.51	8-10	9.33±1.15
11/7	17-32	25.67±7.77	9-16	13.67±4.04
11/9	19-22	20.33±1.53	12-15	13.00±1.73
11/10	21-30	24.67±4.73	12-15	13.67±1.53
Mean (days)	-	23.60±3.87	-	11.20±2.28

Table 4: Morphology of male and female spikes/inflorescences

Geno-types	Male Inflorescence						Female Inflorescence					
	Length (cm)		Diameter (cm)		Male spikes (No.)		Length (cm)		Diameter (cm)		Stigma/ female spikes (No.)	
	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ± SD	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD
9/7	5.30-5.60	5.47 ±0.15	2.36-2.70	2.49 ±0.19	5690-10291	7526 ±2437	7.15-8.35	7.73 ±0.60	4.23-5.10	4.58 ±0.46	4704-5788	5265 ±543
9/8	4.30-5.68	5.03 ±0.69	2.30-2.82	2.50 ±0.28	4576-12941	7719 ±4553	7.10-8.90	8.23 ±0.99	4.20-5.90	5.05 ±0.85	6712-7080	6908 ±185
10/4	8.29-10.90	9.73 ±1.30	2.60-3.78	3.34 ±0.65	9077-14762	12764 ±3197	7.45-9.10	8.32 ±0.83	3.25-4.20	3.68 ±0.48	4720-7832	5973 ±1642
10/6	5.95-6.98	6.54 ±0.54	1.98-2.75	2.41 ±0.39	4005-6032	5053 ±1015	7.95-8.20	8.08 ±0.13	3.45-4.10	3.73 ±0.33	4400-7008	5589 ±1319
10/9	5.02-5.92	5.41 ±0.46	1.65-2.00	1.88 ±0.20	2736-6698	4672 ±1982	6.80-8.65	7.65 ±0.94	3.60-4.79	4.20 ±0.60	4284-6656	5823 ±1334
10/10	4.80-7.10	6.10 ±1.18	1.90-2.32	2.08 ±0.22	4500-9014	6824 ±2259	7.20-9.80	8.12 ±1.46	3.25-4.48	3.96 ±0.64	5088-6048	5501 ±494
11/6	3.80-6.20	5.37 ±1.36	1.60-2.30	1.90 ±0.36	4019-6360	5341 ±1199	6.15-7.85	6.92 ±0.86	3.20-4.40	3.95 ±0.65	4452-5906	5365 ±795
11/7	4.30-7.30	6.05 ±1.56	1.89-2.00	1.93 ±0.61	3710-6179	5224 ±1326	4.65-8.00	6.72 ±1.81	3.18-4.05	3.68 ±0.45	4304-9392	6485 ±2620
11/9	5.38-7.10	6.35 ±0.87	1.80-3.11	2.34 ±0.68	6209-9785	7770 ±1831	5.90-9.00	7.45 ±1.53	3.90-4.75	4.33 ±0.43	3565-9831	6679 ±3133
11/10	4.34-8.52	6.12 ±2.16	1.65-2.60	2.02 ±0.51	6162-7101	6712 ±490	6.60-7.50	7.17 ±0.49	3.61-4.10	3.82 ±0.25	4621-8640	6514 ±2020
Mean	-	6.22 ±1.03	-	2.29 ±0.41	-	6961 ±2029	-	7.64 ±0.96	-	4.10 ±0.52	-	6961 ±1409

Morphology of male and female spikes

The general floral morphologies observed were similar to those previously reported for *A. heterophyllus* (Roy, 1997). Lengths of male inflorescences were 3.8 (genotype 11/6) to 10.9 cm (genotype 10/4) with a diameter of 1.6 (genotype 11/6) to 3.78 cm (genotype 10/4) (Table 4) whereas lengths of female spikes were 4.65 (genotype 11/7) to 9.8 cm (genotype 10/10) and diameters ranged 3.18 (genotype 11/7) to 5.9 cm (genotype 9/8) (Table 4). An average of 6961 numbers of anthers per male inflorescence was found. However, Pushpakumara (2011) reported the length of female inflorescences ranging between 4-12 cm and diameter 2-7 cm at maximum receptivity. Male inflorescences were cylindrical or barrel-shaped, 2-11 cm long and 1-5 cm wide at the time of maximum pollen presentation and were densely covered with minute yellow anthers (5819±498). It was little different with the present investigation.

Male spike opening and anthesis took 16 (genotypes 10/9 and 11/7) to 36 days (genotype 9/7) (Table 5). Azad (1989) reported that 15 to 20 days were required from male spike opening to anthesis. In present study the duration of availability of pollen grains on male spike took 3 days (genotypes 10/10 and 11/6) to 7 days (genotype 11/10) with an average of 4.57 days and like that Tessy and Kumaran (1996) observed that anthesis continued up to 5-7 days in a spike. Roy (1997) reported the availability of pollen grains varied from 4-9 days (average 6.92 days). These findings are in line with the results thus directly influence to draw a conclusion on this aspect of flowering behaviour of jackfruit.

Female spike opening to protrusion of stigma took 5.87 days with a range of 0-16 days (Table 5) and quite similar conclusion was drawn by Mannan *et al.* (2006) where off season jackfruit took an average of 5.43 days for female spike opening to protrusion of stigma. Duration of availability of stigmas on female spike ranged from 12 (genotype 10/6) to 34 days (genotype 11/7) and an average 22.8 days. Similar finding was observed by Tessy and Kumaran (1996) wherein emergence of stigma

Table 5: Duration between male spike opening to anthesis, duration of availability of pollen grains on male spike, duration of female spike opening and protrusion of stigma and duration of availability of stigma on female spike in jackfruit

Genotypes	Duration between male spike opening and anthesis (days)		Duration of availability of pollen grains on male spike (days)		Duration of female spike opening and protrusion of stigma (days)		Duration of availability of stigma on female spike (days)	
	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
9/7	18-36	26.67±9.02	4-5	4.33±0.58	0-9	3.67±4.73	21-25	22.67±2.08
9/8	18-26	23.00±4.36	4-5	4.67±0.58	0-2	0.67±1.15	20-25	21.67±2.89
10/4	20-26	22.00±3.46	4-5	4.33±0.58	5-9	7.33±2.08	15-17	15.67±1.15
10/6	21-25	23.33±2.08	4-6	4.67±1.15	12-14	14.00±2.00	12-17	14.00±2.65
10/9	16-34	25.33±9.02	4-5	4.33±0.58	2-5	3.67±1.53	22-32	26.67±5.03
10/10	21-26	23.33±2.52	3-4	3.67±0.58	0-11	3.67±6.35	23-28	25.33±2.52
11/6	27-32	30.33±2.89	3-6	4.67±1.53	0-16	8.33±8.02	20-28	23.33±4.16
11/7	16-31	25.33±8.14	4-6	5.00±1.00	8-9	8.67±0.58	27-34	30.00±3.61
11/9	18-24	20.33±3.21	4-6	4.66±1.15	4-6	5.00±1.00	22-25	23.67±1.53
11/10	20-26	23.33±3.06	4-7	5.33±1.53	0-8	4.33±4.04	23-26	25.00±1.73
Average	-	24.30±4.78	-	4.57±0.93	-	5.93±3.15	-	22.80±2.74

on female spike was highly erratic and continued for 3-4 weeks. Complete fading away of stigma occurred in 21-35 days after starting of anthesis.

Stigma availability on spike ranged from 12 days (genotype 10/6) to 34 days (genotype 11/7) and receptivity was found 5th days to 34th days after stigma emergence (peaks in 12th and 15th days) (Table 6). Receptivity of individual stigma in jackfruit lasts for 36 h as reported by Sambamurty and Ramalingam (1954). Haque (2001) reported that the period of protrusion of stigma from female spike opening from 0-2 days with an average of 1.05 days and receptivity period of stigma varied from 19-32 days with an average value of 26. Moncur (1985) suggested a long duration of stigmatic receptivity (about two weeks) in *A. heterophyllus*. Lengthy stigmatic receptivity, a common feature of the genus *Artocarpus*, along with other *Artocarpus* species, for example stigma receptivity in *A. odoratissimus* and *A. elasticus* is reported to be two weeks and two months, respectively, in Malaysia (Primack, 1985). Thus, in present study, the morphological features of jackfruit flower revealed similarity over different geographical regions and indicates genetic control of the species.

Table 6: Duration of receptivity of stigmas on female inflorescence

Pollination after days of stigma emergence	No. of fruits set	Pollination after days of stigma emergence	No. of fruits set
5th	3	20th	3
6th	4	21st	1
7th	2	22nd	2
8th	4	23rd	3
9th	3	24th	4
10th	3	25th	3
11th	2	26th	2
12th	5	27th	3
13th	4	28th	1
14th	4	29th	3
15th	5	30th	2
16th	4	31st	2
17th	3	32nd	2
18th	4	33rd	0
19th	3	34th	1

Note: Five buds were pollinated after each days of stigma emergence

Sex ratio

The numbers of male and female spikes of ten genotypes were recorded at 30 days interval during flowering season (December to March). Sex ratio was highest in genotype-9/7 (26:1) in the month of December among all the genotypes under study (Table 7). Ratio was lowest in genotype-11/9 (1.6:1) in the month of February. Maximum flowering (Both male and female) was seen in the month of February in all genotypes under study.

Table 7: Sex ratio (male: female) at different times of flowering period of different jackfruit genotypes

Genotype	December			January			February			March		
	Male	Female	Ratio	Male	Female	Ratio	Male	Female	Ratio	Male	Female	Ratio
9/7	26	1	26.0:1	37	6	6.2:1	126	29	4.3:1	24	2	12.0:1
9/8	23	4	5.8:1	37	10	3.7:1	132	37	3.6:1	19	1	21.0:1
10/4	23	1	23.1:1	56	6	9.3:1	123	18	6.8:1	28	6	4.7:1
10/6	37	2	18.5:1	82	7	11.7:1	143	23	6.2:1	45	3	15.0:1
10/9	43	7	6.1:1	50	14	3.6:1	87	30	2.9:1	22	4	5.5:1
10/10	36	9	4.0:1	85	23	3.7:1	121	60	2.0:1	51	2	25.5:1
11/6	20	3	6.7:1	62	22	2.8:1	126	53	2.4:1	38	5	7.6:1
11/7	63	11	5.7:1	78	32	2.4:1	151	53	2.9:1	18	2	9.0:1
11/9	29	7	4.1:1	46	18	2.5:1	72	45	1.6:1	43	3	14.3:1
11/10	45	13	3.5:1	67	24	2.8:1	112	58	1.9:1	32	3	10.6:1
Average	34.5	5.8	5.9:1	60	16.2	3.7:1	119.3	40.6	2.9:1	32	3.1	10.3:1

Pollen viability and germination percentage

No significant differences were observed in case of pollen viability though it was highest on the 4th days to full coverage of male spikes with flowers with 77.9%. The staining capacity of acetocarmine depends not only on the viability of the pollen but its contents so fresh as well as preserved pollen often gets stained irrespective of viability (Vasil, 1958). Pollen germination was high during initial days which decreases with maturity. Pollen germination was highest (60.87%) on 2nd day to full coverage of male spikes. The data in Table 8 clearly showed the differences between pollen stainability and pollen germinability. Einhardt *et al.* (2006), Santos *et al.* (2006) and Nyine and Pillay (2007) found similar results in their experiments, emphasizing that pollen grain viability assessment through the staining method likely seems to express the germination potential, but not its occurrence.

Table 8: Percentage of viable pollen and geminated pollen grains in male spikes

Days to full coverage of male spikes with flowers	Viability (%)	Germination (%)
1st	73.76	59.74
2nd	75.54	60.87
3rd	77.26	59.96
4th	77.92	58.86
5th	74.04	56.29
6th	73.52	54.51
$CD_{0.05}$	-	2.15
S.E.m (±)	2.044	0.69

The present study provided a basic information on the floral biology of jackfruit. Morphological features of jackfruit flower revealed similarity over different geographical regions and indicated genetic control of the species. But as jackfruit is a heterozygous crop and environment influences phenotypes of species, phenological variations was observed when compared with earlier reports. Two specific new phenomena were detected i.e. sequences of flowering in footstalk showed eighteen different types of sequences and male spike opening and anthesis took 16-36 days. Genotype-10/9, genotype-11/6, genotype-11/9 and genotype-11/10 were found to be better in respect of time required for floral bud development, number of female flowers per footstalk, days required for successive spike opening, female spike opening and protrusion of stigma, availability of stigmas on female inflorescences and sex ratio. In case of pollen study, it was found that jackfruit pollens have high viability.

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