

Original research article

Genetic variability in flowering and fruiting behaviors of litchi varieties and hybrids

Abstract:

An investigation was undertaken to study the variability in litchi hybrids developed at BAU, Sabour and their parents with respect to flowering and fruiting behavior. The experiment was carried out in Horticulture garden Bihar Agricultural University, Sabour. A critical analysis of the data for various characters of flowering and fruiting parameters like date of panicle initiation, duration of panicle emergence, flowering duration, flower colour, inflorescence shape and size, maturity period and fruit morphology were taken. Initiation of panicle emergence varied from 21/01/2013 (H-587, H-590) to 17/02/2013 (H-141, Kasba). Duration of anthesis varied from 25/02/2013 (H-517, H-574, H-598 & Early Bedana) to 12/03/2013 (H-70, H-104) and maturity period ranged from 55 to 68 days. Among different genotypes, H-73, H-98, H-104, H-510 had fruit shape oval to round similar to their male parent Bedana. Dark red fruit colour of H-70, H-73, H-104, H-566 also resembled Bedana i.e. their male parent. Significant genetic variability was found among the genotypes with respect to flowering characters, thus there is an ample scope for selection of promising genotypes. Thus from above finding it may be concluded that extended period of flowering, fruit set and harvesting span could be achieved through hybridization.

INTRODUCTION

Litchi (*Litchi chinensis* Sonn.) is one of the most popular subtropical edible fruits of the [sapindaceae Sapindaceae](#) family. It is considered as the queen of the fruits due to its attractive colour, excellent quality, juicy fruit, sour and sweet taste, characteristic pleasant flavour and nutritional value. Bihar is the leading state in litchi production in India with 31480_hectare land under litchi cultivation in the state with annual production of 23420 MT.

The genetic base of litchi germplasm is quite narrow and presently most of the cultivated varieties are the result of clonal selection or seedling selection (Gupta *et al.*, 2017). More than 20

litchi varieties are grown in the state, but all matures within 25 days of short span from 3rd week of May to 2nd week of June. Variability in litchi is very less regarding flowering, fruiting pattern and harvesting span. The effectiveness and efficacy of crop improvement depend upon the presence of genetic variability in the population under selection. Hence, hybridization is one of the important tools to create variability and to get the variety of desired type. Efforts were undertaken at Bihar Agricultural University, Sabour to create variability in litchi genotype through hybridization for further improvement.

Litchi cultivars vary greatly in vegetative flushing pattern, flush colour and flowering ability. Genetic diversity in litchi is indicated by a large number of cultivars in China and India, which provides the basis of selection for development of new cultivars. Very little information is available on flowering habit and floral biology of litchi, factors that are important for varietal improvement. Floral initiation, the first step in the reproductive cycle holds the key role in the productivity of litchi plants in warm subtropical region (Das *et al.*, 2002). Environmental conditions during winter are very critical for litchi production, because vegetative growth in the one to two months prior to panicle emergence completely eliminates flowering (Menzel *et al.*, 1988). In litchi, floral initiation takes place only after the shoots have undergone a period of vegetative dormancy

The litchi hybridization work has been taken as one of the most important crop improvement programme in this institute for developing litchi hybrids. Thus efforts were made to study the extent of variability created due to hybridization pertaining to flowering and fruiting pattern of these hybrids and their parents.

MATERIAL AND METHODS

The present investigation was carried out at the Horticultural Garden, Bihar Agricultural College, Sabour during the year 2012-2014 with a view to study flowering and fruiting pattern in 22 litchi hybrids developed at B.A.C. Sabour and the varieties involved in hybridization. Altogether 30 genotypes were evaluated including 8 varieties involved in hybridization. The litchi genotypes used for study are given in Table-1.

60 **Table-1: Details of experimental material**

Treatments	Hybrids/ Genotypes	Parentage	Treatments	Hybrids/ Genotypes	Parentage
T ₁	H-70	(Purbi x Bedana)	T ₁₆	H-574	(Purbi x Bedana)
T ₂	H-71	(Purbi x Bedana)	T ₁₇	H-580	(Purbi x Bedana)
T ₃	H-72	(Purbi x Bedana)	T ₁₈	H-587	(Purbi x Bedana)
T ₄	H-73	(Purbi x Bedana)	T ₁₉	H-588	(Purbi x Bedana)
T ₅	H-98	(Purbi x Early Bedana)	T ₂₀	H-590	(Kasba x Bedana)
T ₆	H-104	(Purbi x Early Bedana)	T ₂₁	H-591	(Kasba x Bedana)
T ₇	H-141	(China x Bedana)	T ₂₂	H-598	(Purbi x Dehra Rose)
T ₈	H-245	(Bedana x China)	T ₂₃	Purbi	-
T ₉	H-503	(Ojhauli x Purbi)	T ₂₄	Bedana	-
T ₁₀	H-510	(Purbi x Bedana)	T ₂₅	China	-
T ₁₁	H-517	(Purbi x Bedana)	T ₂₆	Kasaba	-
T ₁₂	H-518	(Purbi x Bedana)	T ₂₇	Late Bedana	-
T ₁₃	H-526	(China x Bedana)	T ₂₈	Ojhauli	-
T ₁₄	H-566	(Late Bandana x China)	T ₂₉	Early Bedana	-
T ₁₅	H-573	(Purbi x Kasaba)	T ₃₀	Dehra Rose	-

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62 **Floral Characteristics**

63 Floral characteristics of the litchi genotypes like date and duration of panicle emergence, panicle
64 size, number of shoots per panicle, date of anthesis and duration of flowering, inflorescence
65 pattern were studied. For studying flowering characteristics fifteen panicles from three places
66 around the canopy approximately spaced equally (5 in each place) were randomly selected and
67 tagged in all hybrids and varieties under study and each place of selection was considered as
68 replication. Total days taken from panicle emergence to complete the panicle emergence were
69 considered as duration of panicle emergence. Panicle size in terms of length and spread and No.
70 of shoots/panicle was measured in all selected fifteen panicles in each genotype and average of
71 all five panicle at each place was calculated. Date of anthesis and flowering duration was
72 calculated in days from date of opening of first flower to last date of opening of flower. Flower
73 color, shape, compactness, position of Inflorescence was studied by the chart of minimal
74 descriptor of litchi by NBPGR.

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77 **Fruiting characters**

78 Among fruiting characters the observations were taken on initiation and duration of fruit set,
79 maturity period, fruit retention at maturity in all the genotypes under study. Date of fruit set
80 initiation was recorded in each genotype and similarly days taken to mature the fruit from
81 completion of fruit set was also recorded. Fruit set and fruit retention at maturity was recorded at
82 the time of harvesting on the same 15 tagged panicles on which flowers were counted.
83 Observations on fruit morphology such as fruit shape, fruit/peel colour and tubercles shape were
84 taken as per the chart of minimal descriptor of litchi by NBPGR.

85 **RESULTS AND DISCUSSION**

86 A number of observations regarding to flowering and fruiting ~~behaviour~~ behavior were recorded
87 and logical interpretation of result obtained are also discussed for better understanding during the
88 course of present investigation.

89 **Panicle characters**

90 Panicle characters of genotypes like panicle initiation, duration of panicle emergence, panicle
91 length, panicle spread, no. of shoots/panicle and date of anthesis of litchi varieties and their
92 hybrids showed significant variations among themselves (Table-2). The date of panicle initiation
93 varied from 21st Jan (H-587, H-590) to 19th Feb (H-73) in the year 2013. Other hybrids that were
94 earlier to initiate panicle opening were H-588, H-598 (22/01/2013). Among the varieties Purbi
95 (07/02/2013) and Early Bedana (09/02/2013) were earlier to initiate panicle emergence while
96 Kasba was the latest i.e. on 17/02/2013. The minimum duration of panicle emergence of 12 days
97 was found in H-98 & Late Bedana which was statistically at par with H-70 and Early Bedana
98 (13.00 days), H-104 (14.00 days) while maximum duration of 17 days was recorded in hybrids
99 H-588, H-590 & H-591. It was being observed that H-73 and H-141 showed their behavior
100 towards male parent i.e. Bedana having late initiation of panicle. The varieties under evaluation
101 had panicle emergence between 7 to 17th Feb. Thus prolonged period of panicle emergence was
102 observed in hybrids. The duration of panicle emergence of more than one month from first week
103 of January has been reported under Gurdaspur (Punjab) conditions by Chadha and Rajpoot
104 (1969). The cause of variation might be due to environmental conditions. More or less similar
105 trends were observed by Pathak *et al.*, (2013) under West Bengal conditions in litchi. Significant
106 difference in panicle size was also noted with maximum length and spread in Ojhauli (41.38

cm& 44.10 cm) which was at par with Dehra Rose and Kasba having panicle length of (37.55 cm).It was reflected that hybrids and varieties showed no any set trends regarding panicle length and width. It might be due to heterozygous nature of litchi. These differences might be due to the genetic makeup of the cultivars and their response to environmental conditions. The date of anthesis varied from 25th February to 12th March in different litchi genotypes. The earliest flower initiation was noted in H-517, H-574, H-598 & Early Bedana followed by H-518, H-580 and H-590, whereas, H-70 and H-104 were the last in anthesis (12/03/2013) followed by H-73 and H-98 (10/03/2013). Similar variation in flower initiation was also noted by Jambhale *et al*, (2014) in papaya and Kumari, S. (2017) in litchi.

Table-2: Panicle characters, no. of shoots/panicle and anthesis date of litchi hybrids and genotypes

Hybrids / Genotypes	Date of panicle initiation	Duration of panicle emergence (days)	Panicle length (cm)	Panicle spread (cm)	No. of shoots/ panicle	Date of anthesis
H-70	10/02/2013	13.33	18.97	16.50	2.60	12/3/2013
H-71	11/02/2013	14.33	22.34	21.80	2.80	09/03/2013
H-72	12/02/2013	15.33	23.00	20.90	2.70	05/03/2013
H-73	19/02/2013	16.33	26.40	21.70	2.90	10/03/2013
H-98	13/02/2013	12.00	24.20	25.90	3.30	10/03/2013
H-104	18/02/2013	14.00	26.30	28.74	3.21	12/03/2013
H-141	17/02/2013	16.33	23.00	21.12	3.30	09/03/2013
H-245	02/02/2013	15.00	24.50	21.80	2.80	01/03/2013
H-503	28/01/2013	16.33	27.00	25.60	3.60	02/03/2013
H-510	26/01/2013	15.67	21.57	14.60	2.70	28/02/2013
H-517	25/01/2013	16.00	22.60	19.90	2.60	25/02/2013
H-518	24/01/2013	15.67	23.80	20.90	2.70	26/02/2013
H-526	01/02/2013	16.00	26.10	24.50	3.10	27/02/2013
H-566	08/02/2013	16.33	21.50	18.70	2.90	07/03/2013
H-573	29/01/2013	15.00	28.32	23.10	3.10	01/03/2013
H-574	26/01/2013	16.33	20.26	22.90	2.90	25/02/2013
H-580	25/01/2013	16.67	24.40	21.80	2.80	26/02/2013
H-587	21/01/2013	16.00	26.80	24.70	3.20	28/02/2013
H-588	22/01/2013	17.00	25.88	23.80	3.00	29/02/2013
H-590	21/01/2013	17.00	27.00	24.60	3.10	26/02/2013
H-591	27/01/2013	17.00	28.30	25.80	2.54	01/03/2013
H-598	22/01/2013	15.00	30.52	24.50	3.00	25/02/2013
Purbi	07/02/2013	14.33	35.10	31.82	3.90	28/02/2013
Bedana	10/02/2013	14.67	27.67	18.70	2.30	01/03/2013
China	12/02/2013	16.00	34.50	28.00	3.21	03/03/2013
Kasaba	17/02/2013	15.00	37.55	26.80	3.00	09/03/2013
Late Bedana	15/02/2013	12.00	26.00	16.20	2.40	04/03/2013

Ojhauli	11/02/2013	16.00	41.38	44.10	2.90	27/02/2013
Early Bedana	09/02/2013	13.00	24.20	18.12	2.60	25/02/2013
Dehra Rose	16/02/2013	14.33	31.29	38.50	3.20	07/03/2013
Mean		15.27	26.68	23.87	2.94	
C.V.		9.11	8.01	7.87	5.83	
C.D. (P=0.05)		2.27	3.49	3.07	0.28	
Range	21 st Jan-19 th Feb	12-17	18.97-41.38	14.60-44.10	2.30-3.90	25 th Feb-12 th March

119 **Flowering behaviour and inflorescence characters**

120 Significant variations in flowering behaviour with respect to flowering duration, flower colour
121 and pattern of opening of flowers and inflorescence characters pertaining to shape, compactness
122 and position among the genotypes was observed during the study (Table 3). The minimum
123 flowering duration of 9.33 days was in H-503, H-566, H-598 which was statistically at par with
124 H-70 (10.67 days), H-526 (11 days) & H-587 (11 days) while maximum flowering duration of
125 flowering was recorded in genotype Kasba (19.00 days) that was at par with China and Purbi.
126 Flower colour varied from light cream to light yellow & greenish white. The pattern of opening
127 of flowers was found to be similar in almost all the hybrids and genotypes which followed the
128 sequence as first male flower then female flower and lastly pseudo hermaphrodite flower.
129 Likewise, the shape of inflorescence was noted pyramidal in H-70, H-72, H-104, H-245, H-510,
130 H-517, H-580, H-587, H-588, H-598 while H-71, H-141, H-503, H-566, H-573, H-574, Late
131 Bedana, Ojhauli, Early Bedana and Dehra Rose possessed broadly pyramidal shape and it was
132 conical in H-73, H-98, H-590, H-591, Purbi, Bedana, China and Kasba. The genotypes also
133 varied for the compactness of inflorescence from compact, medium compact and loose compact
134 (Table 3).

135 The hybrids showed that the hybrids showed their trend towards male parent for flower
136 colour character, hybrids H-70, H-71, H-72, H-141, H-510, H-517, H-574, H-580, H-588 & H-
137 591 showed their trend towards male parent that is Bedana and H-98 & H-104 towards male
138 parent Early Bedana. The variations might be due to genetic behaviour of the cultivars as floral
139 characters are less affected by the environmental conditions. More or less similar variations with
140 respect to flower colour were reported by Khurshid *et al.*, (2004) in litchi and Ulemale and
141 Tambe, (2015) in guava.

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144 **Table-3: Flowering behavior and inflorescence characters of litchi varieties and hybrids**

Hybrids / Genotypes	Flowering Duration (days)	Flower colour	Inflorescence shape	Inflorescence compactness	Inflorescence position
H-70	10.67	light cream	pyramidal	medium	terminal
H-71	11.33	light cream	broadly pyramidal	compact	terminal
H-72	12.00	light cream	pyramidal	compact	Both*
H-73	14.67	light yellow	conical	medium	Both*
H-98	15.00	light cream	conical	medium	terminal
H-104	11.67	light cream	pyramidal	compact	Both*
H-141	13.33	light cream	broadly pyramidal	medium	terminal
H-245	12.67	greenish white	pyramidal	medium	terminal
H-503	9.33	light cream	broadly pyramidal	compact	terminal
H-510	12.00	light cream	pyramidal	medium	terminal
H-517	15.00	light cream	pyramidal	compact	terminal
H-518	14.00	light yellow	conical	medium	Both*
H-526	11.00	light yellow	conical	loose	Both*
H-566	09.33	light cream	broadly pyramidal	medium	terminal
H-573	14.00	greenish white	broadly pyramidal	compact	terminal
H-574	14.00	light cream	broadly pyramidal	compact	Both*
H-580	17.67	light cream	pyramidal	compact	terminal
H-587	11.00	greenish white	pyramidal	compact	terminal
H-588	14.00	light cream	pyramidal	compact	terminal
H-590	16.00	light yellow	conical	medium	terminal
H-591	12.00	light cream	conical	medium	terminal
H-598	09.33	light yellow	pyramidal	medium	terminal
Purbi	18.00	light yellow	conical	compact	Both*
Bedana	14.00	light cream	conical	compact	Both*
China	18.67	light yellow	conical	medium	terminal
Kasaba	19.00	greenish white	conical	loose	terminal
Late Bedana	13.00	light yellow	broadly pyramidal	compact	Both*
Ojhauri	14.33	light yellow	broadly pyramidal	loose	terminal
Early Bedana	16.00	light cream	broadly pyramidal	medium	terminal
Dehra Rose	13.67	light yellow	broadly pyramidal	loose	Both*
Mean	13.56				
Range	9.33-19.00				
C.V.	9.10				
C.D. (P=0.05)	2.02	-	-	-	-

* - both axillary and terminal

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150 **Fruiting behaviour and fruit morphology**

151 The genotypes under study varied with respect to fruit set, no. of fruits / panicle at harvest and
152 maturity period and fruit physical characters pertaining to shape, fruit or peel colour at maturity
153 and tubercles shape (Table-4).

154 Initiation of fruit set started on 15th March and completed on 6th April during 2013 in different
155 genotype under study. Early fruit set was observed in Ojhauri, Dehra Rose, H-590 & H-587, H-
156 588, H-526, Early Bandana & H-574, H-580 in 3rd week of March, while fruit set was seen late in
157 H-73 and H-104, H-71, H-72, H-98, H-245, H-141, H-70 and Kasba i.e in 1st week of April. It
158 was observed that hybrids like H-590, H-587, H-588, H-526, H-574, H-580, H-518, H-510, H-
159 517 and H-591 showed their trend towards male parent i.e. Bedana for initiation of fruit set .
160 Marked varietal differences in initiation of fruit set have also been reported by (Chadha and
161 Rajpoot, 1969, and Kumari *et al*, 2018) in litchi. Early fruit set in some of the varieties are
162 probably due to early panicle emergence, early anthesis and subsequently early fruit set in these
163 genotypes. Earlier reports confirmed the present finding as enunciated by various workers who
164 reported the varying degree of fruit set depending upon tree cultivar and environmental condition
165 (Sanyal *et al.*, 1996, and Ray *et al.*, 2002)..

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166 A significant variation in no. of fruits /panicle at harvest and maturity period was also observed
167 among the litchi hybrids and varieties under study. Significantly maximum no. of fruits/panicle
168 at harvest was recorded in China (17.2) followed by Purbi (15.24) and Kasba (14.70) whereas
169 minimum no. of fruits/panicle at harvest was recorded in H-566 (5.9/ panicle). Variation in fruit
170 set and fruit retention in litchi in different area has also been reported by Ray *et al.* (2002), and
171 Kumari *et al.* (2018) in litchi. H-591 took maximum duration for maturity (68.67 days) which
172 was at par with H-590, H-573, H-590, H-73, H-588 & Late Bedana, whereas minimum maturity
173 period was recorded in Ojhauri (55.00 days) and it was at par with H-104, H-517, H-518 and
174 Dehra Rose. Menzel and Simpson (1992) and Gaur and Bajpai (1990) also enunciated variation
175 in maturity period in different litchi cultivars.

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Table-4: Fruiting behavior/characters of litchi varieties and hybrids

Hybrids / Genotypes	Initiation of fruit set	Fruits/ panicle at harvest	Maturity period of fruits (days)	Fruit shape	Fruit colour/ Peel colour	Tubercles shape*
H-70	02/04/2013	6.30	63.00	oblong	dark red	P
H-71	05/04/2013	6.50	59.67	oblong	dull red	MP
H-72	04/04/2013	7.10	62.67	oblong	dull red	F
H-73	06/04/2013	7.20	66.33	round	dark red	P
H-98	03/04/2013	6.14	62.67	oval	reddish yellow	MP
H-104	06/04/2013	6.36	57.33	oval	dark red	F
H-141	02/04/2013	6.55	61.00	oblong	greenish red	MP
H-245	03/04/2013	8.58	64.00	oblong	dull red	F
H-503	24/03/2013	6.38	61.00	conical	pinkish red	F
H-510	22/03/2013	7.11	61.00	round	red	F
H-517	24/03/2013	6.34	58.00	conical	dark red	P
H-518	22/03/2013	6.70	59.00	oval	dull red	MP
H-526	20/03/2013	6.20	62.67	round	dull red	P
H-566	28/03/2013	5.90	61.00	oblong	dark red	MP
H-573	24/03/2013	6.10	66.67	oval	pinkish red	MP
H-574	20/03/2013	6.20	59.33	oval	dark red	F
H-580	21/03/2013	7.30	65.00	round	dull red	MP
H-587	18/03/2013	6.80	60.67	round	dull red	F
H-588	20/03/2013	7.70	66.33	oval	dull red	MP
H-590	18/03/2013	7.30	67.37	oval	dark red	P
H-591	25/03/2013	6.90	68.67	oblong	dull red	MP
H-598	27/03/2013	10.90	59.67	conical	dark red	F
Purbi	26/03/2013	15.24	60.67	oblong	dark red	MP
Bedana	22/03/2013	7.20	62.67	round	dark red	F
China	28/03/2013	17.20	63.45	conical	red	P
Kasaba	02/04/2013	14.70	61.67	conical	red	P
Late Bedana	27/03/2013	6.40	66.33	round	red	F
Ojhauri	15/03/2013	13.70	55.00	oblong	red	P
Early Bedana	20/03/2013	8.10	59.67	round	red	F
Dehra Rose	16/03/2013	10.30	59.33	conical	greenish red	MP
Mean		8.18	62.06			
C.V.		7.23	4.38			
C.D. (P=0.05)		0.97	4.45	-	-	-
Range	15 th March 6 th April	5.90-17.20	55.0-68.67			

*P(Pointed), MP (Medium Pointed), F (Flattened)

Shape of fruit varied from oblong to round and oval to conical in different genotypes. It was reflected that H-73, H-98, H-104, H-510 had fruit shape oval to round that was similar to pollen parent Bedana. Dark red fruit colour of H-70, H-73, H-104, H-566 also resembled with Bedana i.e. their male parent. Variation in peel colour was also recorded in different litchi genotype.

The data with respect to tubercles shape indicated that the shape of tubercles was pointed in H-70, H-73, H-517, H-526, H-590, China, Kasaba and Ojhauri while the shape of tubercles in H-71, H-98, H-141, H-518, H-566, H-573, H-580, H-588, H-591 & Dehra Rose was medium pointed and it was approximately flattened in H-72, H-104, H-245, H-503, H-510, H-574, H-587, H-598, Purbi, Bedana, Late Bedana and Early Bedana.

CONCLUSION

Litchi varieties and their hybrids differed significantly for their flowering and fruiting behaviour. Panicle initiation in different genotypes varied from 21/01/2013 to 19/02/2013. The varieties under evaluation had panicle emergence between 7 to 17th Feb. Thus prolonged period of panicle emergence was observed in hybrids. Duration of panicle emergence in different litchi varieties and hybrids ranged between 12 to 17 days. Hybrids showed their behaviour towards the parents having smaller panicle size. Anthesis date among genotypes under study varied from 25th Feb to 12th March. H-70, H-73, H-98 and H-104 were latest in flower opening whereas anthesis in the parent varieties was in between 27th Feb to 9th March. Thus extended period of anthesis in litchi genotype could be achieved through hybridization. H-73, H-98, H-104, H-510 had fruit shape oval to round similar to their male parent Bedana. Dark red fruit colour of H-70, H-73, H-104, H-566 also resembled Bedana i.e. their male parent.

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