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

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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 genoty[pes. 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 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 31480hectare 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.

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 xChina)	T_{29}	EarlyBedana	-
T_{15}	H-573	(Purbi x Kasaba)	T_{30}	Dehra Rose	-

The litchi varieties used in the crossing programme are layered plants of recognised variety i.e multiplied by layering. The hybrid developed after crossings are seedling plants. Thus the Treatment T_1 to T_{22} are seedling and T_{23} to T_{30} are clonal.

Floral Characteristics

Floral characteristics of the litchi genotypes like date and duration of panicle emergence, panicle size, number of shoots per panicle, date of anthesis and duration of flowering, inflorescence pattern were studied. For studying flowering characteristics fifteen panicles from three places around the canopy approximately spaced equally (5 in each place) were randomly selected and

tagged in all hybrids and varieties under study and each place of selection was considered as replication. Total days taken from panicle emergence to complete the panicle emergence were considered as duration of panicle emergence. Panicle size in terms of length and spread and No. of shoots/panicle was measured in all selected fifteen panicles in each genotype and average of all five panicle at each place was calculated. Date of anthesis and flowering duration was calculated in days from date of opening of first flower to last date of opening of flower. Flower color, shape, compactness, position of Inflorescence was studied by the chart of minimal descriptor of litchi by NBPGR.

Fruiting characters

Among fruiting characters the observations were taken on initiation and duration of fruit set, maturity period and fruit retention at maturity in all the genotypes under study. Date of fruit set initiation was recorded in each genotype and similarly days taken to mature the fruit from completion of fruit set was also recorded. Fruit set and fruit retention at maturity was recorded at the time of harvesting on the same 15 tagged panicles on which flowers were counted. Observations on fruit morphology such as fruit shape, fruit/peel colour and tubercles shape were taken as per the chart of minimal descriptor of litchi by NBPGR. The data collected were analyzed for variation among genotypes as suggested by Fischer (1948) using RBD.

RESULTS AND DISCUSSION

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

Panicle characters

Panicle characters of genotypes like panicle initiation, duration of panicle emergence, panicle length, panicle spread, no. of shoots/panicle and date of anthesis of litchi varieties and their hybrids showed significant variations among themselves (Table-2).The date of panicle initiation varied from 21stJan (H-587, H-590) to 19th Feb (H-73) in the year 2013.Other hybrids that were earlier to initiate panicle opening were H-588, H-598 (22/01/2013). Among the varieties Purbi (07/02/2013) and Early Bedana (09/02/2013) were earlier to initiate panicle emergence while Kasba was the latest i.e. on 17/02/2013.The minimum duration of panicle emergence of 12 days

was found in H-98 & Late Bedana which was statistically at par with H-70 and Early Bedana (13.00 days), H-104 (14.00 days) while maximum duration of 17 days was recorded in hybrids H-588, H-590 & H-591.It was being observed that H-73 and H-141 showed their behavior towards male parent i.e. Bedana having late initiation of panicle. The varieties under evaluation had panicle emergence between 7 to 17th Feb. Thus prolonged period of panicle emergence was observed in hybrids. The duration of panicle emergence of more than one month from first week of January has been reported under Gurdaspur (Punjab) conditions by Chadha and Rajpoot (1969).The cause of variation might be due to environmental conditions. More or less similar trends were observed by Pathak *et al*., (2013) under West Bengal conditions in litchi. Significant 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 differed significantly regarding panicle size pertaining to panicle length and width. However, it was noted that the hybrids having Bedana as a pollen parent exhibited smaller panicle. 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). 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. 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	21st Jan-19th Feb	12-17	18.97-41.38	14.60-44.10	2.30-3.90	25th Feb-12th March

Flowering behaviour and inflorescence characters

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

varied for the compactness of inflorescence from compact, medium compact and loose compact (Table 3).

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

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*
Ojhauli	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**

Fruiting behaviour and fruit morphology

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

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

A significant variation in no. of fruits /panicle at harvest and maturity period was also observed among the litchi hybrids and varieties under study. Significantly maximum no. of fruits/panicle at harvest was recorded in China (17.2) followed by Purbi (15.24) and Kasba (14.70) whereas minimum no. of fruits/panicle at harvest was recorded in H-566 (5.9/ panicle). Variation in fruit set and fruit retention in litchi in different area has aslo been reported by Ray et al, (2002) and Kumari et al, (2018) in litchi. Higher fruit set in these varieties might be due to large panicle size and higher number of functionally female (FF) flowers. H-591 took maximum duration for maturity (68.67 days) which was at par with H-590, H-573, H-590, H-73,H-588 & Late Bedana , whereas minimum maturity period was recorded in Ojhauli (55.00 days) and it was at par with

H-104,H-517, H-518 and Dehra Rose. Menzel and Simpson (1992) and Gaur and Bajpai (1990) also enunciated variation in maturity period in different litchi cultivars.

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
Ojhauli	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	15th March 6th 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 ion 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 Ojhauli 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 behavior. 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.

REFERENCES

Chadha, K.L. and Rajpoot, M.S. 1969. Studies on floral biology, fruit set and its retention and quality of some litchi varieties. *Indian J. Hort.* **26:** 124-129.

Das, B., Nath, V. and Dey, P. 2004. Investigations on flushing and panicle emergence in litchi under sub-humid sub-tropical plateau region of eastern India. *Ind. J. Hort.* **61(1):** 1-5.

Das, B., Sureja, A.K. and Jindal, P.C. 2002. Flowering and fruit set in Lychee *(Litchi chinensis*Sonn.) - A review. *Agric. Rev.* **23:** 59-64.

Gaur, G.S. and Bajpai, P.N. 1990. Some aspects of developmental physiology of the litchi fruits.*Ind.J.Hort*. **35(3):** 173-177.

Gupta, A.K., Nath, V., Singh, A., Singh, M., Marboh, E.S., Pandey, S., Pathak, A. 2017. Systemic Information for Future Perspectives in Litchi Crop Improvement.Lychee Disease Management. pp, 109-137.

Jambhale V.M. ,Kute,N,S, and Pawar, S.V. 2014. Studies on genetic variability parameters, character association and path analysis among yield and yield contributing traits in papaya [*Carica Papaya* (l.)].*The Bioscan* 9(4): 1711-1715, 2014

Khurshid, S., Ahmad, I. and Anjum, M.A. 2004. Genetic diversity in different morphological characteristics of litchi (*Litchi chinensis*Sonn.).*Int. J. Agri. Biol.* **6:** 1062-1065.

Menzel, C.M. 1983. The control of floral initiation in litchi: a review. *Scientia Hortic*.**21:** 201-215.

Menzel, C.M. and Simpson, D.R. 1992. Growth, flowering and yield of litchi cultivars.*Scientia Hortic*.**49:** 243-254.

Menzel, C.M., Caeseldine, M.L. and Simpson, D.R. 1988. Crop development and leaf nitrogen in lychee in sub-tropical Queensland.*Australian J. Expt. Agric.* **28:** 793-800.

Pathak, P.K., Ray Dutta, S.K. and Mitra, S.K. 2013. Studies on floral biology of seven litchi (*Litchi chinensis*Sonn.) cultivars.*J. Hort. Sci.* **8(1):** 25-29.

Sanyal, D., Biswas, B. and Mitra, S.K. 1996. Studies on flowering of litchi cv. Bombai I effect of chemicals and cicturing. *Haryana J. Hort. Sci*. **25(1):** 29-34.

Kumari, Shweta .2017. Studies on pheno-physiology and pollination in commercial cultivars of litchi (*Litchi chinensis* Sonn.). M.Sc,thesis submitted to BAU, Sabour

Kumari1, Shweta , Rani ,R. , Chandola J. C., Mir ,H., Ahmad, M. F.and Bharti, A. 2018 Effect of pollination method on fruit set in commercial cultivars of litchi **.** ***Int.J.Curr.Microbiol.App.Sci 7*(5) 603-606**

Ray, P.K., Rani, R. and Singh, S.K .2002. Sex ratio and fruit set pattern in ten litchi cultivars. Prog. Hort. 34(1) 17-21

Ulemale, P. H.and Tambe, T. B..2015. Variability in growth parameters of red fleshed and white fleshed guava genotypes. *The bioscan.*10 (2): 885-887

Veera, S. and R.C. Das. 1974. Effect of 2,4-D, NAA, GA and 2,4,5-T on initial set, retention and growth of fruits in litchi, var Muzaffarpur. *Hort. Adv.***9:** 11–13.