Floral Biology and Pollination Behaviour in Bottle Gourd Under Hilly Condition of Uttarakhand

Abstract

An experiment was conducted at College of Horticulture, Uttarakhand University of Horticulture and Forestry Bharsar Pauri Gharwal to observed the floral biology and Poliination Behaviour of ten genotypes (G_1 to G_{10}) bottle gourd during the period from March 2022 to August 2022. The flower has five petals. The different parameters for floral biology and pollination behavior was recorded on the basis of time period. The experiment was laid out in field condition is RCBD with three replication and ten genotypes and for lab condition experiment was laid out is CRD with three replication and nine treatments. The purpose of this investigation was to study variation in floral biology and pollination behaviour among collected genotypes. The genotypes Pusa Summer Prolific Long (PSPL) took minimum 38.333days to first male flowering and for female flowering it took 40.667 days. The genotype L. C. Meerut has given better in terms of maximum 7.100cm male flower length and for female flower length it was 7.500cm. The genotype Pusa Summer Prolific Long (PSPL) had maximum (81.000mm) diameter of male flower. Arka Bahar had maximum (86.000mm) diameter of female flower. Best result for sex ratio was seen in L. C. Tehri (105.000). Anthesis in different genotypes of bottle gourd started from 5.00 am and flower continued to open till 11.00 am and the peak period for anthesis in all the genotypes recorded in between 6.00 am to 8.00 am. Anther dehiscence is increased gradually from 6.00 am to 11.00 am. The peak period of anther dehiscence was recorded between 6.00 am to 8.00 am. While maximum percentage of stigma receptivity of fruit set was observed during full bloom stage followed by bud stage and withering stage in every genotype under observation. The fruit set by hand pollination was maximum (80.000%) in PSPL and by open pollination maximum (86.000%) fruit set was recorded in genotype Arka Bahar. Hence, present investigation suggested that in terms of Pollen viability and pollen germination Arka Bahar showed better result over the other genotypes. Maximum pollen longevity was shown by Arka Bahar followed by L. C. Saharanpur. Pollen germination was maximum in 15% and 20% solution of sucrose and in boric acid it was observed maximum in 0.2%, 0.3%.

Keywords: Floral biology, Anthesis, Anther dehiscence, Pollination, Pollen viability, pollen longevity, pollen germination.

Introduction

Bottle gourd (*Lagenaria siceraria* L.) belongs to the family Cucurbitaceae, is an important and popular vegetable. High genotypic coefficient of variation values for yield/plant, number of fruits/plant, fruit length and fruit breadth and wider range of variation indicate more opportunity for selection of better genotypes (Rajesh *et al*., 1999; Ram *et al*., 2005). In nature, bottle gourd exhibits great morphological and genetic variability and could wide environmental adaptation (Koffi, 2009). Bangladeshi farmers used different local cultivars and released (from different organization) bottle gourd variety. But their yield is not in satisfactory level. Varietal performance might be helpful to overcome this problem. Considering these circumstances the present study was undertaken with a view to evaluate the growth and yield performance of eleven bottle gourd lines.

Material and methods

The general climatic condition of Bharsar is represented as mild summer, high precipitation and colder to severely cold prolonged winter. The South-East monsoon commences towards the end of June while the North-East monsoon causes occasional winter showers during November to February. The area receives frequent snowfall during winter (Bisht and Sharma 2014).

Bottle gourd thrives well under sandy loam to clay soils with the pH value of 5.4 to 7.0. Well drained soils with good organic matter are best by

bottle gourd cultivation perform better in well drained and organic matter rich soil.

Pits of (30 x 30 x 30) cm^3 size were prepared in each plot with a spacing of 2.5 m x 2 m. In Nursery seeds sown in polybags on 15/ March/2022 inside the polyhouse.

Seedlings of different genotypes were transplanted in the experimental plot on 21/April/2022 at a spacing of 2.5 m x 2 m. Mechanical support through Oak (*Quercus*) sticks were provided for better growth and yield.

Days to first flowering was recorded for both male and female flowers by counting the days from transplanting until the day on which first flower opened on the selected plants of each treatment and averaged over replications. The selected plants were observed daily to record the date of first flowering. Day to first male and female flowering will be recorded from day to transplanting plant in the field. In each replication visually seen the first flower is male or female flower.

Fully opened staminate and pistillate flowers were collected from the field and brought to the laboratory. The flowers were dissected under a stereo-binocular microscope to study the detailed structure.

Longevity of flowers is the time taken by a particular flower from anthesis till it sets into fruit or till it withered and dropped off. Thirty (30) buds of staminate and pistillate flowers were serially numbered using tags and were observed daily to record the day of anthesis. The opened flowers were further monitored till they set fruits or dropped.

Flower lengths of both male and female flowers were measured using scale when the flowers were freshly opened and bloomed. Flower length was measured from five male and five female buds of each of both the plants from each treatment and averaged over replications.

Flower diameter of both male and female flowers were measured by using digital Vernier caliper when the flowers were freshly opened and bloomed. Flower diameter was measured from five male and five female buds of each of both the plants from each treatment and averaged over replications.

The stigmatic receptivity of different treatments was determined by using fruit set method. 10 buds from 2 plants of each genotype were selected at different ages (bud stage, full bloom and withering stage). All the buds of different ages were pollinated and bagged. Number of fruit set will be recorded.

It was determine by counting male and female flowers on ten (10) days different nodes and internodes of each plants from each treatment and averaged over replications.

Data was collected consecutively for 10 days from 14/06/2022 till 24/06/2022. Each day 20 flowers buds (both male and female), 10 each of 2 selected plants from each replication was selected and tagged. Flowers expected to open next day were tagged in the evening hours and observations were recorded at hourly intervals from 5:00AM to 11:00AM onwards till complete opening of all flowers. The opened flowers were removed every time at an interval of hour. Time of complete opening of flowers was noted and percentage was determined by computing the mean frequency of flower opening over various time slots.

Hence, observations were recorded for anther dehiscence at different times of the day by tagging 10 randomly selected staminate flower buds from 2 selected plant of each genotype at hourly intervals for 10 consecutive days. Observations were recorded in the freshly opened flowers with the help of hand lens at hourly intervals from 5:00 AM to 11:00AM onward still complete dehiscence. The anther dehiscence (release/appearance of powdery mass) in flowers was observed visually. Time of anther bursting and release of pollen from pollen sac were noted to determine the peak period of dehiscence in various cultivars under study.

Result and Discussion

Bottle gourd being a monoecious, male and female flowers are borne separately on the same plant but at different internodes. For transfer of pollen from a staminate flower to the stigma of a pistillate flower an external agent is essential for successful pollination and fruit set. The possibility of wind pollination is ruled out since the pollen grains are sticky. The flowers are a rich source of nectar and pollen, and attract a number of insect visitors, of which a few may be effective pollinators for perpetuation of the plant.

Bottle gourd is a monoecious, annual vine pubescent herb with five angled stem, stem is profusely branched. The flowers are large, unisexual, white, solitary, showy. The flower has five petals. The staminate flower are on long pedicels than female and hermaphrodite flower and exceeding the foliage. Ovary may be round, ovate long or cylindrical. There are three stamens, two as compound and one as single.

Thamburaj and Singh (2000) observed that the pumpkin plant bears 2-3 branches with thick stem, flowers are unisexual, solitary and are lemon yellow-deep orange in colour.

The flowers lasted for less than a day. In summer the flowers closed much earlier probably because of temperature while, in post monsoon

season they seldom closed. Low temperature might be the reason for some of the flower not closing during post monsoon season because opening and closing of flowers is regulated by relative humidity and light intensity.

The variations observed in the number of days taken to male flowering were found to be significant in the genotypes under study. The cultivar PSPL took minimum days to flowering are 38.333 days. Similar result had been reported by Kumari *et al.* (2017) while working genetic diverse of bitter gourd (*Momordica charanita* L.). The present findings are in conformity Pal *et al.* (1976) reported that bitter gourd vines started flowering 40 days after sowing and blooming period varied from 68 to 76 days.

The time of anthesis was recorded on an hourly interval in July 2022. The peak period of anthesis was recorded from 6 to 8am in both male and female flower. In genotype first maximum anthesis percentage was recorded in male flower is 90% and minimum is 10%.

Hawthorn and Pollard (1954) found that anthesis in watermelon and muskmelon occurs from one to two hours after sun-shine and the flowers closed before evening. The results of present study are in accordance with the study of Kalloo (1988), Chand *et al*. (1990), Ram (1997), Ramirez *et al*. (2002) and Thu (2012) in cucumber. They reported that anthesis started from 4:00am to 7:30am and flowers became fully open from 6:00am to 9:55am and completed anthesis in about 4 to 7 hours on the same day. Flower closure in both the sexes is initiated at about 9:00am of the same day. Final closure takes place between 11:00am and 12:00pm in the male and about 10:00am in the female. Flower once closed doesn't open again.

Anther dehiscence is the final function of anther that causes the release of pollen grains. This process is coordinated precisely with pollen differentiation, floral development and flower opening. In bottle gourd, anther split longitudinally along a definite stomium. In this study observations on time of anther dehiscence were recorded for ten days. Observation regarding the time of anther dehiscence was also recorded at one hour interval between 5-11 am. The peak period of anther dehiscence we recorded between 6-8am. Maximum anther dehiscence is in cultivar Arka Bahar, PSPL, L. C. Tehri, L. C. Saharanpur, L. C. Meerut and L. C. Bharsar maximum during 6-8am (90%), and minimum anther dehiscence is 10% in all the cultivars. Time of anther dehiscence helps in carrying out crossing activities as well as it helps in understanding the synchronicity in monoecious flowers. The present findings are in conformity with Choudhury and Pathak (1961) in cucumber, Pal and Singh (1972) in bitter gourd; Chand *et al*. (1990), Poal (1995) and Ram (1997) in cucumber**.** Rubina (2010) observed that the anther dehiscence initiated at 07.30 am, immediately after the opening of flower.

Male flower buds took on an average 17 to 19 days, whereas female buds took 21 to 22 days for their complete development.

The cultivar PSPL took minimum days (40.667) for female flowering and this variation due to different genetic constitution or when diverse genotypes is subjected to a particular environment condition they act accordingly. The difference in flowering time in bottle gourd genotypes is also reported by Kappal *et al*. (2015).

The genotype L. C. Meerut (7.100cm) had maximum length in male flower, where as in female flower maximum flower length was (7.500cm). This report is supported by the Deyto and Cervancia, 2009, according to him female flowers bear large sized petals and their sepals are short and strong scented than the male flowers.

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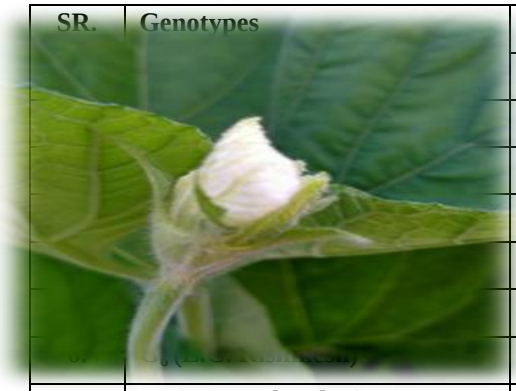
Table 1- Mean performance for days to first male and female flowering in different genotypes of *Lagenaria siceraria* (Mol.) Standl.

SR.	Genotypes	Days to first male and female flowering ± SE(m)	
		Male	Female
		44.000±2.000	44.667±1.453
		38.333±1.202	40.667±0.667
		46.333±1.453	47.667±1.453
		46.000±2.309	47.000±1.732
		44.333±2.028	48.000±1.528
		45.333±0.667	48.000±1.155
7.	**G_7 (L.C. Dehradun)**	41.667± 2.186	50.667±0.333
8.		48.333±1.202	50.667±0.667
9.	**G_9 (Kashi Ganga)**	41.000±1.528	44.667±1.764
10.	**G_{10} (L.C. Bharsar)**	43.333±1.202	46.000±2.309
	Grand mean	43.866	51.800
	SE(d)	2.280	1.693
	C.D	4.828	3.585



Male flower

Male bu

Female Bud

Female Flo

Fig 1: Male and female flowering of *Lagenaria siceraria*

Table 2- Mean performance for flower length (male and female) in different genotypes of *Lagenaria siceraria* (Mol.) Standl.

Sr. No.	Genotypes	Flower length male ± SE	Flower length female ± SE
1.	G_1 (Arka Bahar)	6.233±0.696	5.467±0.203
2.	G_2 (PSPL)	5.033±0.742	7.500±0.577
3.	G_3 (L. C. Tehri)	5.567±0.657	5.500±0.577
4.	G_4 (L. C. Saharanpur)	6.367±0.467	5.300±0.200
5.	G_5 (L. C. Meerut)	7.100±0.306	5.767±0.371
6.	G_6 (L.C. Rishikesh)	4.500±0.529	5.167±0.333
7.	G_7 (L.C. Dehradun)	4.700 ±0.643	6.833±0.333
8.	G_8 (L.C. Karnal)	4.500±0.416	4.833±0.333
9.	G_9 (Kashi Ganga)	6.500±0.577	5.500±0.577
10.	G_{10} (L.C. Bharsar)	4.767±0.267	6.033±0.291
	Grand mean	5.526	5.790
	SE(d)	0.735	0.504
	C.D.$_{(0.05)}$	1.555	1.068

Table 3- Mean performance for sex ratio (male/female) in different genotypes of *Lagenaria siceraria* (Mol.) Standl.

Sr. No.	Genotypes	Sex ratio ± S.E.(m)
1.	G_1 (Arka Bahar)	149.000 ±2.082
2.	G_2 (PSPL)	147.333 ±13.860
3.	G_3 (L. C. Tehri)	105.000 ±7.638
4.	G_4 (L. C. Saharanpur)	115.000 ±5.774
5.	G_5 (L. C. Meerut)	105.667 ±4.702
6.	G_6 (L.C. Rishikesh)	113.333 ±4.410
7.	G_7 (L.C. Dehradun)	165.000 ±2.887
8.	G_8 (L.C. Karnal)	120.000 ±5.774
9.	G_9 (Kashi Ganga)	129.000± 5.859
10.	G_{10} (L.C. Bharsar)	169.000± 2.082
	Grand mean	131.833
	SE(d)	7.469
	C.D. $_{(0.05)}$	15.813

Maximum sex ratio was observed in L. C. Bharsar (169.000). Variation in sex ratio may be due to the adaptability of different genotypes was also reported by Munshi and Acharya (2005) and Samadia (2002) in bottle gourd. The

staminate to pistillate flower ratio varied greatly between species of cucurbits 3:1 in pumpkin (Kumar, 2006), 6:1 in cucumber (Rubina, 2010), 2:1 in bottle gourd (Srikanth, 2012), 13:1 in bitter gourd (Mary *et al.*, 2012) and 18:1 in case of musk melon (Sidda, 2015). In study staminate to pistillate flower ratio in ridge gourd was relatively high (23:1). This higher ratio clearly indicates that it is highly male biased and that the plants are adapted to get maximum pollen deposition on stigma after sufficient pollen gathering by foraging bees. Pumpkin plant produces more of male flowers than female flowers (Akoroda *et al*., 1990; Suzanne *et al*., 2000).

Table 4- Variation in anthesis and dehiscence per cent among different genotypes of *Lagenaria siceraria* (Mol.) Standl.

Time of anthesis and dehiscence														Temperature (°C)		Humidity
Male								Female								
Days	No. of buds	5-6am	6-7am	7-8am	8-9am	9-10am	10-11am	5-6am	6-7am	7-8am	8-9am	9-10am	10-11am	Max.	Mini.	%
G_1 (Arka Bahar)																
1.	20	60	70	70	60	0	0	20	40	40	0	0	0	29	16	75
2.	20	50	60	40	30	0	0	30	60	40	20	10	0	28	16	74
3.	20	80	90	90	80	50	50	10	30	30	30	30	20	24	15	72
4.	20	30	50	30	30	10	0	20	40	40	30	20	10	21	13	77
5.	20	50	60	40	20	0	0	10	30	30	20	10	0	26	19	63
6.	20	50	70	70	50	30	10	30	40	40	0	0	0	21	12	70
7.	20	50	80	80	40	20	0	40	50	10	0	0	0	20	14	74
8.	20	40	60	40	20	10	0	30	20	20	10	10	0	21	13	69
9.	20	30	70	60	40	20	10	20	40	20	10	0	0	22	14	72
10.	20	40	70	50	30	10	0	20	40	30	20	10	0	23	19	71
Mean	20	48	68	57	40	15	7	23	39	30	14	9	3			
G_2 (PSPL)																
1.	20	40	70	60	0	0	0	20	40	40	20	20	0	29	16	75
2.	20	60	60	80	40	40	0	10	40	30	30	0	0	28	16	74
3.	20	30	90	90	40	40	0	30	60	40	30	10	0	24	15	72
4.	20	40	70	90	50	50	20	60	80	50	40	0	0	21	13	77
5.	20	50	80	60	30	30	0	10	30	20	20	10	0	26	19	63
6.	20	30	50	70	40	30	10	20	40	40	30	20	10	21	12	70
7.	20	20	50	80	30	20	0	10	30	30	20	10	0	20	14	74
8.	20	40	53	80	50	30	0	20	30	20	10	0	0	21	13	69
9.	20	50	80	60	40	20	10	30	50	40	30	20	10	22	14	72
10.	20	30	50	30	20	10	10	40	70	60	40	30	10	23	19	71
Mean	20	39	66	70	34	27	5	25	47	37	27	12	3			
G_3 (L. C. Tehri)																
1.	20	20	50	60	60	40	20	10	20	20	10	0	0	29	16	75
2.	20	10	30	80	60	30	10	20	50	50	30	20	10	28	16	74
3.	20	20	60	90	60	20	10	20	60	60	40	20	20	24	15	72
4.	20	30	50	90	70	40	20	10	40	50	30	20	10	21	13	77

5.	**20**	40	70	60	50	30	10	10	20	20	20	0	0	26	19	63
6.	**20**	30	40	40	30	10	0	30	40	40	30	10	0	21	12	70
7.	**20**	20	30	50	40	20	0	20	40	40	30	10	0	20	14	74
8.	**20**	30	60	60	30	10	0	10	20	30	20	10	0	21	13	69
9.	**20**	10	30	40	20	10	0	30	60	60	50	40	10	22	14	72
10.	20	20	10	30	10	10	0	10	40	40	30	20	10	23	19	71
Mean	**20**	**23**	**43**	**60**	**43**	**22**	**7**	**17**	**39**	**41**	**29**	**15**	**6**			
G_4 (L. C. Saharanpur)																
1.	**20**	10	40	40	20	0	0	20	40	40	30	10	0	29	16	75
2.	**20**	30	50	50	40	0	0	10	30	30	20	0	0	28	16	74
3.	**20**	20	40	30	30	10	10	20	50	50	40	20	0	24	15	72
4.	**20**	30	90	70	70	60	0	10	20	20	10	0	0	21	13	77
5.	**20**	40	70	60	40	30	0	10	30	30	20	0	0	26	19	63
6.	**20**	30	60	70	50	20	10	20	40	40	50	30	10	21	12	70
7.	**20**	20	70	70	60	30	10	20	30	30	20	10	0	20	14	74
8.	**20**	30	80	80	40	20	0	10	30	30	20	10	0	21	13	69
9.	**20**	10	50	50	20	10	0	10	20	20	10	10	0	22	14	72
10.	**20**	30	60	60	50	30	10	10	40	40	30	20	0	23	19	71
Mean	**20**	**25**	**61**	**58**	**42**	**21**	**4**	**14**	**33**	**33**	**25**	**11**	**1**			
G_5 (L. C. Meerut)																
1.	**20**	30	60	60	50	30	20	20	30	40	30	10	10	29	16	75
2.	**20**	20	50	50	30	10	0	10	30	50	30	10	10	28	16	74
3.	**20**	40	70	70	60	50	0	10	20	40	20	20	20	24	15	72
4.	**20**	30	70	70	50	30	10	30	50	50	20	10	0	21	13	77
5.	**20**	70	90	90	20	0	0	10	30	30	20	10	0	26	19	63
6.	**20**	20	60	60	50	40	0	20	30	30	30	20	10	21	12	70
7.	**20**	40	70	50	50	30	10	10	20	40	30	20	10	20	14	74
8.	**20**	30	50	30	30	20	10	10	40	50	30	10	0	21	13	69
9.	**20**	50	60	50	50	30	10	20	30	40	20	10	0	22	14	72
10.	**20**	30	40	40	30	20	10	10	20	30	10	0	0	23	19	71
Mean	**20**	**36**	**62**	**57**	**42**	**26**	**7**	**15**	**30**	**40**	**24**	**12**	**6**			
G_6 (L. C. Rishikesh)																
1.	**20**	20	30	30	20	10	0	20	30	30	20	10	0	29	16	75
2.	**20**	30	60	70	50	30	20	30	40	30	10	0	0	28	16	74
3.	**20**	30	40	50	30	20	10	10	30	20	20	10	10	24	15	72
4.	**20**	40	60	50	30	10	0	10	20	20	10	10	10	21	13	77
5.	**20**	20	30	50	20	10	10	20	50	30	20	20	10	26	19	63
6.	**20**	30	40	40	30	20	20	20	40	40	30	10	0	21	12	70
7.	**20**	30	50	60	30	20	10	10	30	30	20	10	0	20	14	74
8.	**20**	20	40	50	30	10	0	20	50	30	20	10	0	21	13	69
9.	**20**	10	40	40	30	20	10	10	40	20	10	0	0	22	14	72
10.	**20**	20	50	30	30	20	10	20	20	30	20	0	0	23	19	71
Mean	**20**	**25**	**44**	**47**	**30**	**17**	**9**	**17**	**35**	**28**	**18**	**8**	**3**			
G_7 (L. C. Dehradun)																
1.	**20**	40	60	60	40	30	0	30	40	40	30	20	10	29	16	75
2.	**20**	30	80	80	60	50	20	20	30	50	40	30	20	28	16	74
3.	**20**	40	60	60	20	20	0	40	50	50	30	10	0	24	15	72
4.	**20**	20	50	50	40	20	10	20	40	50	20	0	0	21	13	77

5.	**20**	30	80	80	60	40	20	40	60	60	30	10	0	26	19	63
6.	**20**	20	60	60	40	20	0	20	50	50	30	0	0	21	12	70
7.	**20**	30	50	50	30	20	0	20	40	50	40	20	10	20	14	74
8.	**20**	40	60	50	30	10	0	30	50	60	50	30	20	21	13	69
9.	**20**	50	70	70	40	20	0	20	30	40	30	20	0	22	14	72
10.	**20**	30	60	0	30	20	0	30	50	70	40	30	10	23	19	71
Mean	**20**	**33**	**63**	**56**	**39**	**25**	**5**	**27**	**44**	**52**	**34**	**17**	**7**			
G_8 (L. C. Karnal)																
1.	**20**	60	90	80	70	50	20	20	40	40	30	20	0	29	16	75
2.	**20**	50	70	60	30	20	10	30	30	30	10	0	0	28	16	74
3.	**20**	30	50	30	30	10	0	30	50	40	40	40	20	24	15	72
4.	**20**	40	60	60	50	20	0	20	30	30	20	10	0	21	13	77
5.	**20**	30	60	70	60	30	0	10	20	30	10	10	0	26	19	63
6.	**20**	60	80	80	70	40	20	30	60	60	50	30	10	21	12	70
7.	**20**	40	70	60	40	20	10	40	50	50	30	20	0	20	14	74
8.	**20**	30	50	50	30	20	10	20	30	30	20	10	0	21	13	69
9.	**20**	50	60	50	20	10	0	20	40	40	20	10	0	22	14	72
10.	**20**	20	70	70	50	30	10	30	50	50	30	20	10	23	19	71
Mean	**20**	**41**	**66**	**61**	**45**	**25**	**8**	**25**	**40**	**40**	**26**	**17**	**4**			
G_9 (Kashi Ganga)																
1.	**20**	40	70	60	0	0	0	30	50	50	30	20	10	29	16	75
2.	**20**	20	40	30	30	0	0	40	60	50	30	10	0	28	16	74
3.	**20**	10	50	40	40	40	20	20	40	40	20	10	0	24	15	72
4.	**20**	30	50	50	40	20	10	20	50	50	30	10	0	21	13	77
5.	**20**	20	60	60	40	0	0	30	30	30	20	20	10	26	19	63
6.	**20**	30	50	40	30	30	10	30	50	60	30	20	10	21	12	70
7.	**20**	40	70	60	40	20	10	20	40	30	20	10	0	20	14	74
8.	**20**	**20**	**60**	**60**	**30**	**20**	**10**	**10**	**30**	**30**	**20**	**10**	**0**	21	13	69
9.	**20**	10	60	60	30	10	0	30	50	30	30	20	10	22	14	72
10.	**20**	30	50	50	20	10	0	40	50	40	30	20	10	23	19	71
Mean	**20**	**25**	**56**	**51**	**30**	**15**	**6**	**27**	**45**	**41**	**26**	**15**	**5**			
G_{10} (L. C. Bharsar)																
1.	20	20	80	80	70	50	30	30	50	50	0	0	0	29	16	75
2.	20	40	50	70	80	60	20	20	60	50	30	0	0	28	16	74
3.	20	30	90	60	50	30	10	30	40	40	30	20	10	24	15	72
4.	20	40	90	70	40	20	10	20	50	40	20	10	10	21	13	77
5.	20	50	80	60	40	20	0	30	60	60	30	20	10	26	19	63
6.	20	60	70	50	30	10	0	30	60	50	40	30	20	21	12	70
7.	20	40	60	40	20	0	0	20	70	70	40	20	10	20	14	74
8.	20	30	80	80	70	20	10	10	50	50	30	10	0	21	13	69
9.	20	50	90	60	40	30	10	30	40	30	20	0	0	22	14	72
10.	20	30	80	50	30	20	10	20	30	20	10	10	0	23	19	71
Mean	**20**	**39**	**77**	**62**	**47**	**26**	**10**	**24**	**51**	**46**	**25**	**12**	**6**			

Reference

Akoroda, M. O., Ogbechie- Odiaka, N. I., Adebayo, M. L., Ugwo, O. E. and Fuwa, B. 1990. Flowering,

pollination and fruiting in fluted pumpkin (*Telfairia occidentalis*). *Scientia Horticulturae*. 43(**3-4**): 197-206.

Bisht, A. S. and Sharma, K. D. 2014. Plant utilization by the communities of Bharsar and adjoining area of Pauri Garhwal District, Uttarakhand, India. *Biodiversitas Journal of Biological Diversity.* 15(**1**): 94-100.

Chand, S., Kumar, J. and Arya, P. S. 1990. Pollination and seed setting studies in cucumber. *Vegetable Science*. 17: 99-101.

Choudhury B., Phatak S. C. 1961. Studies on floral biology in cucumber (*Cucumis sativus* L.). *Indian Journal of Horticulture*. 18(**3**): 212-221.

Deyto, R. C. and Cervancia, C. L. 2009. Floral biology and pollination of Ampalaya (*Momordica charantia* L.). *Philippine Agricultural Scientist*. 92(**1**): 8-18.

Hawthorn, L. R. and Pollard, L. H. 1954. Vegetable and Flower Seed Production. *Journal of New Seeds*. 1(**3-4**). 626.

Kalloo. 1988. *Vegetable Breeding*. CRC Press, Florida. 239p.

Kappal, S. B., Chawan, B., Rathod, R. H. and Shantappa, T. 2015. Variability and characters, association studies in ridge gourd (*Luffa acutangula* Robx) reference to yield attributes. *Journal of Global Bioscience.* 4(**5**): 2332-2342.

Koffi, K. K., Anzara, G. K., Malice, M., Dje, Y., Bertin, P., Baudoin, J., Zoro, Bi, I. A. 2009. Morphological and allozyme variation in a collection of *Lagenaria siceraria* (Molina) Standl. from Cote d'Ivoire.

Kumari, P., Kumari, R., Rani, N., Verma, R. B. and Verma, R. (2017). Genetic divergence of bitter gourd (*Momordica charantia* L.) for sixteen important yield attributing traits. Current Journal of Applied Science and Technology, 23(2): 1-11.

Mary, G., Muo, K. and Kraemer, M. 2012. Pollinator diversity, behaviour and limitation on yield of karela (*Momordica charantia* L. Cucurbitaceae) in Mary Lucy Oronje, Melanie Hagen Western Kenya. *African Journal of Agricultural Research.* 7(**11**): 1629-1638.

Morimoto, Y., Gikungu, M., Maundu, P. 2004. Pollinators of the bottle gourd (*Lagenaria siceraria*) observed in Kenya. *International Journal of Tropical Insect Science.* 24(**1**): 79-86.

Munshi, R., Acharyya, P. 2005. Varietal evaluation in bottle gourd genotypes. *Indian Agriculture*. 49(**3-4**): 213-221.

Pal, U. R., Singh, U. R. and Maury, R. A. 1972. Floral biology of Bitter gourd. *Indian Journal of Horticulture.* 29(**1**): 73-76.

Percivel. 1979. Flower biology. Britain: Pagebros. (Norwich) Ltd., Great Britain publisher. 13p.

Poal, D. K. 1995. Pollination and Seed Setting Studies in some Genetic Stocks of Cucumber (*Cucumis sativus* L.). Thesis, M.Sc. Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan (HP). 19p.

Rajesh, K., Singh, D.K., Ram, H. H., Kumar, R. 1999. Manifestation of heterosis in bottle gourd (*Lagenaria siceraria* (Mol) Stand L.). Annals of Agricultiral. Research. 20(**2**): 177-179.

Ram D, Singh RS, Pandey S, Rai M. 2005. Study of polygenic traits in off season bottle gourd (*Lagenaria siceraria* (Mol) Stand L.). Vegetable Science. 32(**2**): 189-191.

Ram, H. H. 1997. Vegetable Breeding. Principles and Practices. Ed. Kalyani publishers, Ludhiana, New Delhi-Noida pp.322-323.

Ramirez, V. M., Rueda, M. S., Tabla, P. V., Ayala, R. and Navarro, J. 2002. Diversity of native bee visitors of cucurbit crops (Cucurbitaceae) in Yucatan, Mexico. *Journal of Insect Conservation.* 6(**3**): 135-147.

Rubina, K. S. 2010. Pollinators Diversity with special reference to role of honeybees in quantitative and qualitative improvement of cucumber, (*Cucumis sativus* L.). Thesis, M.Sc. University of Agricultural Sciences, Bangalore. 1-52p.

Rubina, K. S. 2010. Pollinators Diversity with special reference to role of honeybees in quantitative and qualitative improvement of cucumber, (*Cucumis sativus* L.). Thesis, M.Sc. University of Agricultural Sciences, Bangalore. 1-52p.

Samadia, D. K. 2002. Performance of bottle gourd genotypes under hot arid environment. *Indian Journal of Horticulture*. 59(**2**): 167-170.

Sidda, R. 2015. Role of flower visitors in pollination and fruit set of muskmelon (*Cucumis melo* L.). Thesis, M.Sc. University of Agricultural Sciences Bangalore. 1-52p.

Suzanne, C. S., Chris, H. W. and Roger, A. M. 2000. Flowering and Fruit Set of Pumpkin Cultivars under Field Conditions. *Horticulture Science*. 35(**6**): 1074–1077.

Thu, M. K. 2012. Pollination biology of *Cucumis sativus* L. (Cucumber) in Hmawbi Township. *Universities Reseach Journal*. 5: 189-199.