



ISSN (E): 2277- 7695  
 ISSN (P): 2349-8242  
 NAAS Rating: 5.23  
 TPI 2021; SP-10(6): 91-95  
 © 2021 TPI  
[www.thepharmajournal.com](http://www.thepharmajournal.com)  
 Received: 16-04-2021  
 Accepted: 18-05-2021

**Jignesh D Patel**  
 PhD Scholar, Department of  
 Entomology, NM College of  
 Agriculture, Navsari  
 Agricultural University, Navsari,  
 Gujarat, India

**JJ Pastagia**  
 Principal, College of Agriculture,  
 Navsari Agricultural University,  
 Waghai, Gujarat, India

## To study the pollinator fauna of bitter gourd and their foraging behaviour in natural pollination and augmentation of *Apis cerana* bees to natural pollination

Jignesh D Patel and JJ Pastagia

### Abstract

The bitter gourd flowers were found to be visited by three species of honey bees viz., *A. dorsata*, *A. cerana*, *A. florea* as well as stingless bees, lepidopterans, coleopterans, dipterans and hemipterans. Among different flower visitors, in natural pollination, honey bees were the major visitors of bitter gourd flower constituted (72.33% of total visitors) which was followed by sting less bees (11.94%), lepidopterans (5.12%), hemipterans (3.92%), dipterans (3.63%) and coleopterans (3.06%) during summer 2018 while during summer 2019, honey bees constituted 74.98 per cent which was followed by stingless bees (8.99%), lepidopterans (4.92%), coleopterans (3.58%), dipterans (4.35%) and hemipterans (3.19%). Among different bee species, *A. dorsata* was the predominant flower visitors constituting 30.46 per cent of total flower visitors during summer 2018 and 31.20 per cent of total flower visitors during summer 2019. The mean activity of total visitors during 2018 was maximum at 11 00 h (12.86 visitors/m<sup>2</sup>/5 minute). The lowest activity of flower visitors was observed at 13 00 h (1.11 visitors/m<sup>2</sup>/5 minute). During summer 2019, the mean activity of flower visitors was maximum at 10 00 h (12.96 visitors/m<sup>2</sup>/5 minute). While, the lowest activity of flower visitors was recorded at 14 00 h (0.86 visitors/m<sup>2</sup>/5 minute). In treatment of augmentation of *A. cerana* bees to natural pollination, during summer 2018, honey bees were the major visitors of bitter gourd flower constituted 70.02 per cent which was followed by stingless bees (9.83%), lepidopterans (6.06%), dipterans (5.10%), coleopterans (4.69%) and hemipterans (4.29%). Similarly during summer 2019, honey bees constituted 75.64 per cent which was followed by stingless bees (10.18%), lepidopterans (4.69%), dipteran flies (3.62%), coleopterans (2.96%) and hemipterans (2.91%). Among different bee species, *A. cerana* was the predominant flower visitors constituting 36.13 per cent of total flower visitors during summer 2018 and 39.75 per cent during summer 2019. The mean activity of total visitors during 2018 were more at 10 00 h (13.13 visitors/m<sup>2</sup>/5 minute). The lower activity of flower visitors was observed at 13 00 h (1.14 visitors/m<sup>2</sup>/5 minute). During summer 2019, the mean activity of flower visitors was more at 11 00 h (18.46 visitors/m<sup>2</sup>/5 minute). The lower activity of flower visitors was recorded at 14 00 h (1.18 visitors/m<sup>2</sup>/5 minute).

**Keywords:** pollinators, *Apis cerana*, bitter gourd, foraging behaviour, augmentation

### Introduction

Cucurbits form an important and vast group of vegetable crops cultivated extensively in India. The Cucurbitaceae family is comprised of many species of 'vine-crops' like watermelon, pumpkin, cucumber, muskmelon, chow-chow, coccinia, bitter gourd, ash gourd etc. Cucurbit vegetables are fair source of thiamine and riboflavin. It is widely distributed in China, Malasia and tropical Africa. It is cultivated throughout India and it is also found growing as a wild crop in many parts of the country. It is known by different names such as Balsam pear or bitter cucumber in English, Karela in Hindi, Gujarati and Punjabi, Karle in Marathi, Beet karela in Assamese, Kakarakaya in Telugu, Pavakai in Tamil and Hagalakayi in Kanada. Bitter gourdis being cultivated in an area of about 101 thousand hectares in India with a production of 1214 thousand MT and productivity of 12.02 MT per hectare as per second advance estimates during 2019 (Anon., 2020a) <sup>[1]</sup>. The Bitter gourd growing states in India are Andhra Pradesh, Chhattisgarh, Odisha, Karnataka, Maharashtra, Tamil Nadu, Kerala and Gujarat etc. (Anon., 2020b) <sup>[2]</sup>.

Pollination is achieved by abiotic and biotic means. Abiotic pollination occurs mainly by wind (anemophily) and water (hydrophily). Biotic pollination includes mainly vertebrate pollination (zoophily) and insect pollination (Entomophily). Bee, flies, butterflies, moths, wasps, beetles, thrips and some other insects play a major role in pollination process. Among the insects, hymenopterans (largest and diversified assemblages of beneficial insects with nearly 2,50,000 described species) are highly evolved and constitute the most important group of pollinating insects.

**Corresponding Author:**  
**JJ Pastagia**  
 Principal, College of Agriculture,  
 Navsari Agricultural University,  
 Waghai, Gujarat, India

## Materials and Methods

The experiments were conducted at Farmers field of bitter Gourd in The Dangs District, Gujarat, India during summer 2018 and 2019. The experiment was laid down with two treatments viz., in one plot Natural pollination was there and in another plot augmentation of *A. cerana* bees were made in addition to natural pollination. For the purpose, two different fields with same variety with same sowing dates at a distance of 500 m in the same village were selected. The experimental plots were kept free from any insecticidal sprays during flowering period. Observations on different flower visitors visiting the bitter gourd in both the experimental plots were recorded at weekly interval during flowering period from 06 00 h to 18 00 h for five minutes in each square meter area from five spot during peak flowering period. The data were later averaged time wise and group wise to infer the pollinator fauna as well as the dominance of particular group.

## Results and Discussion

Flower Visitors of Bitter gourd in Natural Pollination and augmentation of *A. cerana* bees to natural pollination

The bitter gourd flowers in both the treatments were found to be visited by three species of honey bees viz., *A. dorsata*, *A. cerana*, *A. florea* as well as stingless bees, lepidopterans, coleopterans, dipterans and hemipterans. In natural pollination, honey bees were the major visitors of bitter gourd flower constituted during summer 2018 (72.33% of total visitors) which was followed by sting less bees (11.94%), lepidopterans (5.12%), hemipterans (3.92%), dipterans (3.63%) and coleopterans (3.06%). Similarly during summer 2019, honey bee were the major visitors constituted 74.98 per cent which was followed by stingless bees (8.99%), lepidopterans (4.92%), coleopterans (3.58%), dipterans (4.35%) and hemipterans (3.19%).

In treatment of augmentation of *A. cerana* bees to natural pollination, honey bees were the major visitors of bitter gourd flower constituted 70.02 per cent which was followed by stingless bees (9.83%), lepidopterans (6.06%), dipterans (5.10%), coleopterans (4.69%) and hemipterans (4.29%) summer 2018, while during summer 2019, honey bees were the major visitors of bitter gourd flower constituted 75.64 per cent which was followed by stingless bees (10.18%), lepidopterans (4.69%), dipteran flies (3.62%), coleopterans (2.96%) and hemipterans (2.91%).

The present finding on activities of honey bees is also in line with Atwal (1970) and Rubina (2010), they recorded that *A. dorsata* as a most abundant species on cucurbitaceous flowers in different regions. Satheesha (2010) & Revanasidda and Belavadi (2019) [6] recorded higher activity of *A. cerana* However, Subhakar *et al.* (2011) recorded the highest abundance of *T. iridipennis*.

### Activity of different flower visitors on bitter gourd flowers in natural pollination

Among different bee species, *A. dorsata* was the predominant flower visitors (1.27bees/m<sup>2</sup>/5 minute) constituting 30.46 per cent of total flower visitors which was followed by *A. cerana* (1.10 bees/m<sup>2</sup>/5 minute) and *A. florea* (0.65 bees/m<sup>2</sup>/5 minute) which constituting 26.30 and 15.57 per cent of total flower visitors, respectively during summer 2018. Similarly, during summer 2019, the maximum bee activity was exhibited by the *A. dorsata* (1.30 bees/m<sup>2</sup>/5 minute) followed by *A. cerana* (1.17 bees/m<sup>2</sup>/5 minute) and *A. florea* (0.66 bees/m<sup>2</sup>/5 minute) which constituted 31.20, 27.96 and 15.82

per cent of total flower visitors, respectively. Apart from honey bees, the activity of stingless bees, lepidopterans, coleopterans, dipterans and hemipterans were reported to be 0.50, 0.21, 0.13, 0.15 and 0.16 visitors/m<sup>2</sup>/5 minute constituting 11.94, 5.12, 3.06, 3.63 and 3.92 per cent of the total visitors, respectively. The corresponding values for the summer 2019 was 0.38, 0.21, 0.15, 0.18 and 0.13 visitors/m<sup>2</sup>/5 minute for stingless bees, butterflies, coleopterans, dipterans and hemipterans which constituted 8.99, 4.92, 3.58, 4.35 and 3.19 per cent of the total visitors, respectively. The mean activity of total visitors during 2018 was maximum at 11 00 h (12.86 visitors/m<sup>2</sup>/5 minute). The lower activity of flower visitors was observed at 13 00 h (1.11 visitors/m<sup>2</sup>/5 minute). During summer 2019, the mean activity of flower visitors was maximum at 10 00 h (12.96 visitors/m<sup>2</sup>/5 minute). The lower activity of flower visitors was recorded at 14 00 h (0.86 visitors/m<sup>2</sup>/5 minute). Maximum activity of *A. dorsata*, *A. cerana* and *A. florea* as well as stingless bee was observed at 11 00 h (4.31 bees/m<sup>2</sup>/5 minute), 10 00 h (3.69 bees/m<sup>2</sup>/5 minute), 11 00 h (2.03 bees/m<sup>2</sup>/5 minute) and 11 00 h (1.40 bees/m<sup>2</sup>/5 minute), respectively during summer 2018. Whereas, minimum activity of visitors was observed at 16 00 h (0.11 bees/m<sup>2</sup>/5 minute) followed by 15 00 h (0.20 bees/m<sup>2</sup>/5 minute), 13 00 h (0.11 bees/m<sup>2</sup>/5 minute) and 14 00 h (0.17 bees/m<sup>2</sup>/5 minute). During summer 2019, the activity of *A. dorsata*, *A. cerana* and *A. florea* as well as stingless bee was observed maximum at 11 00 h (4.51 bees/m<sup>2</sup>/5 minute), 10 00 h (4.17 bees/m<sup>2</sup>/5 minute), 10 00 h (2.51 bees/m<sup>2</sup>/5 minute) and 11 00 h (1.17 bees/m<sup>2</sup>/5 minute), respectively while, minimum activity recorded at 13 00 h (0.14 bees/m<sup>2</sup>/5 minute), 14 00 h (0.09 bees/m<sup>2</sup>/5 minute), 14 00 h (0.03 bees/m<sup>2</sup>/5 minute) and 14 00 h (0.06 bees/m<sup>2</sup>/5 minute), respectively. Apart from bee species, the activities of lepidopterans, coleopterans, dipterans and hemipterans were found maximum at 11 00 h (0.60 visitors/m<sup>2</sup>/5 minute), 12 00 h (0.29 visitors/m<sup>2</sup>/5 minute), 11 00 h (0.43 visitors/m<sup>2</sup>/5 minute) and 11 00 h (0.49 visitors/m<sup>2</sup>/5 minute), respectively during summer 2018. Minimum activity of visitors was observed at 13 00 h (0.03 visitors/m<sup>2</sup>/5 minute) which was followed by 08 00 h (0.09 visitors/m<sup>2</sup>/5 minute), 13 00 h (0.06 visitors/m<sup>2</sup>/5 minute) and 15 00 h (0.009 visitors/m<sup>2</sup>/5 minute). During summer 2019, maximum activity of lepidopterans, coleopterans, dipterans and hemipterans was recorded at 11 00 h (0.54 visitors/m<sup>2</sup>/5 minute), 11 00 h (0.49 visitors/m<sup>2</sup>/5 minute), 11 00 h (0.49 visitors/m<sup>2</sup>/5 minute) and 11 00 h (0.46 visitors/m<sup>2</sup>/5 minute), respectively while, minimum activity was observed at 13 00 h (0.06 visitors/m<sup>2</sup>/5 minute), 15 00 h (0.08 visitors/m<sup>2</sup>/5 minute), 14 00 h (0.11 visitors/m<sup>2</sup>/5 minute) and 14 00 h (0.03 visitors/m<sup>2</sup>/5 minute), respectively.

The present finding are more or less in conformity with the earlier workers like Eswarappa (2001) [4] reported that the activity of different species of bees in open plots was found to be maximum at 10 00-11 00 h and lowest at 06 00 h. Prakash (2002) [5] revealed that the activity of *A. cerana* in open plots was maximum at 10 00 h and lowest at 18 00 h.

### Activity of different flower visitors on bitter gourd flowers in augmentation of *A. cerana* to natural pollination

Among different flower visitors, the honey bees were the major visitors of bitter gourd flower during summer 2018 (70.02%) and summer 2019 (75.64%) of total visitors. Among different bee species, *A. cerana* was the predominant flower

visitors (1.50 bees/m<sup>2</sup>/5 minute) constituting 36.13 per cent of total flower visitors which was followed by *A. dorsata* (0.88 bees/m<sup>2</sup>/5 minute) and *A. florea* (0.53 bees/m<sup>2</sup>/5 minute) which constituting 21.26 and 12.63 per cent of total flower visitors, respectively during summer 2018. During summer 2019, the maximum bee activity was exhibited by the *A. cerana* (2.29 bees/m<sup>2</sup>/5 minute) followed by *A. dorsata* (1.23 bees/m<sup>2</sup>/5 minute) and *A. florea* (0.84 bees/m<sup>2</sup>/5 minute) constituted 39.75, 21.29, and 14.60 per cent of total flower visitors, respectively. Apart from honey bees, the activity of stingless bees, lepidopterans, coleopterans, dipterans and hemipterans were reported to be 0.41, 0.25, 0.20, 0.21 and 0.18 visitors/m<sup>2</sup>/5-minute constituting 9.83, 6.06, 4.69, 5.10 and 4.29 per cent of the total visitors, respectively. The corresponding values for summer 2019 was 0.59, 0.27, 0.17, 0.21 and 0.17 visitors/m<sup>2</sup>/5 minute for stingless bees, lepidopterans, coleopterans, dipterans and hemipterans which constituted 10.18, 4.69, 2.96, 3.62 and 2.91 per cent of the total visitors, respectively. The mean activity of total visitors during 2018 was maximum at 10 00 h (13.13 visitors/m<sup>2</sup>/5 minute). The lowest activity of flower visitors was observed at 13 00 h (1.14 visitors/m<sup>2</sup>/5 minute). During summer 2019, the mean activity of flower visitors was maximum at 11 00 h (18.46 visitors/m<sup>2</sup>/5 minute) while, it was lowest at 14 00 h (1.18 visitors/m<sup>2</sup>/5 minute). Maximum activity of *A. dorsata*, *A. cerana* and *A. florea* as well as stingless bee was observed at 11 00 h (2.71 bees/m<sup>2</sup>/5 minute), 10 00 h (6.11 bees/m<sup>2</sup>/5 minute), 10 00 h (1.74 bees/m<sup>2</sup>/5 minute) and 10 00 h (1.29 bees/m<sup>2</sup>/5 minute), respectively during summer 2018 whereas, minimum activity was observed at 13 00 h (0.11 bees/m<sup>2</sup>/5 minute), 16 00 h (0.14 bees/m<sup>2</sup>/5 minute), 14 00 h (0.03 bees/m<sup>2</sup>/5 minute) and 14 00 h (0.03 bees/m<sup>2</sup>/5 minute), respectively. During summer 2019, the activity of *A.*

*dorsata*, *A. cerana* and *A. florea* as well as stingless bee were observed maximum at 11 00 h (4.09 bees/m<sup>2</sup>/5 minute), 10 00 h (7.66 bees/m<sup>2</sup>/5 minute), 11 00 h (2.83 bees/m<sup>2</sup>/5 minute) and 11 00 h (1.91 bees/m<sup>2</sup>/5 minute), respectively while, minimum activity recorded at 14 00 h (0.23 bees/m<sup>2</sup>/5 minute), 13 00 h (0.34 bees/m<sup>2</sup>/5 minute), 14 00 h (0.23 bees/m<sup>2</sup>/5 minute) and 15 00 h (0.20 bees/m<sup>2</sup>/5 minute), respectively. Apart from bee species, the activities of lepidopterans, coleopterans, dipterans and hemipterans were found maximum at 11 00 h (0.69 visitors/m<sup>2</sup>/5 minute), 11 00 h (0.54 visitors/m<sup>2</sup>/5 minute), 11 00 h (0.51 visitors/m<sup>2</sup>/5 minute) and 11 00 h (0.49 visitors/m<sup>2</sup>/5 minute), respectively during summer 2018 whereas, minimum activity was observed at 13 00 h (0.11 visitors/m<sup>2</sup>/5 minute), 14 00 h (0.07 visitors/m<sup>2</sup>/5 minute), 13 00 h (0.14 visitors/m<sup>2</sup>/5 minute) and 13 00 h (0.09 visitors/m<sup>2</sup>/5 minute), respectively. During summer 2019, maximum activity of lepidopterans, coleopterans, dipterans and hemipterans was recorded at 10 00 h (0.60 visitors/m<sup>2</sup>/5 minute), 11 00 h (0.60 visitors/m<sup>2</sup>/5 minute) and 11 00 h (0.43 visitors/m<sup>2</sup>/5 minute), respectively while, minimum activity was observed at 14 00 h (0.03 visitors/m<sup>2</sup>/5 minute), 13 00 h (0.09 visitors/m<sup>2</sup>/5 minute), 14 00 h (0.03 visitors/m<sup>2</sup>/5 minute) and 14 00 h (0.03 visitors/m<sup>2</sup>/5 minute), respectively.

The present finding on activities of honey bees is more or less similar with the earlier workers like Deyto and Cervancia (2009) [3], Revanasidda and Belavadi (2019) [6]. They recorded *A. cerana* as most abundant species on cucurbitaceous flowers in different regions. Yogapriya *et al.* (2019) [7] recorded orders like hymenoptera, lepidoptera, diptera, hemiptera and coleoptera was found visiting the bitter gourd flowers maximum from 06 00 to 16 00 h at a varying level.

**Table 1:** Pollinator fauna of bitter gourd during summer 2018 and summer 2019

Sr. No.	Pollinators	Order	Relative abundance of pollinators (%)			
			Natural pollination		Natural pollination with augmentation of <i>A. cerana</i>	
			Summer 2018	Summer 2019	Summer 2018	Summer 2019
1.	<i>A. dorsata</i>	Hymenoptera	30.46	31.20	21.26	21.29
2.	<i>A. cerana</i>	Hymenoptera	26.30	27.96	36.13	39.75
3.	<i>A. florea</i>	Hymenoptera	15.57	15.82	12.63	14.60
4.	Stingless bee	Hymenoptera	11.94	8.99	9.83	10.18
5.	Butterflies	Lepidoptera	5.12	4.92	6.06	4.69
6.	Coleopterans	Coleoptera	3.06	3.58	4.69	2.96
7.	Dipteran flies	Diptera	3.63	4.35	5.10	3.62
8.	Hemipteran bugs	Hemiptera	3.92	3.19	4.29	2.91

**Table 2:** Activity of different flower visitors on bitter gourd at different hours of the day in natural pollination treatment during summer 2018

Time (h)	*Mean number of visitors/m <sup>2</sup> /5 min								Total
	<i>A. dorsata</i>	<i>A. cerana</i>	<i>A. florea</i>	Stingless bee	Lepidopterans	Coleopterans	Dipterans	Hemipterans	
06 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08 00	1.14	1.26	1.09	0.77	0.34	0.09	0.14	0.14	4.97
09 00	2.83	2.77	1.31	1.23	0.37	0.17	0.31	0.31	9.31
10 00	3.51	3.69	1.97	1.26	0.46	0.26	0.29	0.32	11.75
11 00	4.31	3.37	2.03	1.40	0.60	0.23	0.43	0.49	12.86
12 00	3.26	2.17	1.29	0.80	0.49	0.29	0.26	0.35	8.90
13 00	0.23	0.26	0.11	0.14	0.03	0.11	0.06	0.17	1.11
14 00	0.51	0.31	0.03	0.17	0.06	0.14	0.11	0.11	1.46
15 00	0.63	0.20	0.43	0.43	0.29	0.17	0.17	0.09	2.40
16 00	0.11	0.26	0.20	0.29	0.15	0.20	0.20	0.14	1.55
17 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean	1.27	1.10	0.65	0.50	0.21	0.13	0.15	0.16	4.18
Per cent	30.46	26.30	15.57	11.94	5.12	3.06	3.63	3.92	--

**Table 3:** Activity of different flower visitors on bitter gourd at different hours of the day in natural pollination treatment during summer 2019

Time (h)	*Mean number of visitors/m <sup>2</sup> /5 min								Total
	<i>A. dorsata</i>	<i>A. cerana</i>	<i>A. florea</i>	Stingless bee	Lepidopterans	Coleopterans	Dipterans	Hemipterans	
06 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08 00	1.77	1.57	1.06	0.49	0.29	0.26	0.17	0.20	5.80
09 00	2.23	2.06	1.37	0.60	0.44	0.29	0.37	0.26	7.61
10 00	3.80	4.17	2.51	0.91	0.46	0.37	0.40	0.33	12.96
11 00	4.51	3.74	1.54	1.17	0.54	0.49	0.49	0.46	12.94
12 00	3.14	2.40	1.46	0.94	0.29	0.14	0.20	0.09	8.66
13 00	0.14	0.23	0.09	0.26	0.06	0.11	0.14	0.06	1.09
14 00	0.34	0.09	0.03	0.06	0.11	0.09	0.11	0.03	0.86
15 00	0.55	0.43	0.23	0.14	0.17	0.08	0.29	0.17	2.06
16 00	0.47	0.51	0.31	0.31	0.33	0.12	0.19	0.14	2.40
17 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean	1.30	1.17	0.66	0.38	0.21	0.15	0.18	0.13	4.18
Per cent	31.20	27.96	15.82	8.99	4.92	3.58	4.35	3.19	--

**Table 4:** Activity of different flower visitors on bitter gourd at different hours of the day in natural pollination with augmentation of *A. cerana* treatment during summer 2018

Time (h)	*Mean number of visitors/m <sup>2</sup> /5 min								Total
	<i>A. dorsata</i>	<i>A. cerana</i>	<i>A. florea</i>	Stingless bee	Lepidopterans	Coleopterans	Dipterans	Hemipterans	
06 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08 00	0.80	1.54	0.94	0.66	0.37	0.29	0.29	0.23	5.11
09 00	1.89	3.46	1.31	0.97	0.46	0.31	0.40	0.28	9.08
10 00	2.11	6.11	1.74	1.29	0.54	0.43	0.49	0.42	13.13
11 00	2.71	4.66	1.51	1.14	0.69	0.54	0.51	0.49	12.26
12 00	2.57	2.69	0.71	0.60	0.40	0.26	0.23	0.17	7.63
13 00	0.11	0.23	0.14	0.09	0.11	0.23	0.14	0.09	1.14
14 00	0.63	0.31	0.03	0.03	0.17	0.07	0.17	0.14	1.55
15 00	0.34	0.40	0.34	0.26	0.31	0.16	0.23	0.20	2.24
16 00	0.33	0.14	0.09	0.29	0.22	0.26	0.30	0.31	1.94
17 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean	0.88	1.50	0.53	0.41	0.25	0.20	0.21	0.18	4.16
Per cent	21.26	36.13	12.63	9.83	6.06	4.69	5.10	4.29	--

**Table 5:** Activity of different flower visitors on bitter gourd at different hours of the day in natural pollination with augmentation of *A. cerana* treatment during summer 2019

Time (h)	*Mean number of visitors/m <sup>2</sup> /5 min								Total
	<i>A. dorsata</i>	<i>A. cerana</i>	<i>A. florea</i>	Stingless bee	Lepidopterans	Coleopterans	Dipterans	Hemipterans	
06 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08 00	1.37	2.51	1.14	1.06	0.31	0.29	0.23	0.20	7.11
09 00	1.86	4.23	1.26	0.94	0.51	0.31	0.34	0.36	9.82
10 00	3.26	7.66	2.71	1.34	0.60	0.51	0.40	0.35	16.83
11 00	4.09	7.37	2.83	1.91	0.57	0.60	0.66	0.43	18.46
12 00	3.54	5.00	1.57	1.29	0.54	0.17	0.26	0.21	12.58
13 00	0.40	0.34	0.34	0.31	0.23	0.06	0.11	0.17	1.97
14 00	0.23	0.37	0.23	0.17	0.03	0.09	0.03	0.03	1.18
15 00	0.31	1.09	0.49	0.20	0.26	0.10	0.31	0.09	2.84
16 00	0.90	1.23	0.37	0.40	0.46	0.09	0.37	0.34	4.16
17 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean	1.23	2.29	0.84	0.59	0.27	0.17	0.21	0.17	5.77
Per cent	21.29	39.75	14.60	10.18	4.69	2.96	3.62	2.91	--

## References

- Anonymous. Production and yield of bitter gourd advance estimated 2020a. <https://www.indiastat.com/area>
- Anonymous 2020b. <http://aps.dac.gov.in/Public/Repot.aspx>
- Deyto RC, Cervancia CR. Floral biology and pollination of Ampalaya (*Momordica charantia* L.) Philipp. Agri. Scientist 2009;92(1):8-18.
- Eswarappa G. Pollination potentiality of different species of honey bees in increasing the productivity of chow-chow (*Sechiumedule* (Jacq) S. W.) M. Sc. (Agri.) Thesis submitted to University of Agricultural Sciences, Bangalore 2001.
- Prakash KB. Pollination potentiality of Indian honey bee

*viz.*, *Apis cerana* on the production of cucumber (*Cucumis sativus* (Linn.) S. W. Cucurbitaceae). M. Sc. (Agri.) Thesis submitted to University of Agricultural Sciences, Bangalore 2002.

6. Revanasidda, Belavadi VV. Floral biology and pollination in *Cucumis melo* L., a tropical andromonoecious cucurbit. *Journal of Asia-Pacific Entomology* 2019;22(1):215-225.
7. Yogapriya A, Usharani B, Suresh K, Vellaikumar S, Chinniah C. Foraging Behaviour of Major Pollinators in Bitter Gourd. *International Journal of Current Microbiology and Applied Sciences* 2019;8(6):947-954.