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Pollinator diversity and influence of mode of pollination on yield of bottle gourd

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Abstract

The present investigation was made on availability of pollinator fauna of bottle gourd and impact of mode of pollination on the fruit yield of bottle gourd. Bottle gourd flowers attracted a total of nine pollinator species, encompassing eight families and spanning five orders. Of all the insect visitors, lepidopterans (44.44%) were the most prevalent, with coleoptera coming in second at 22.22%. Hemiptera, orthoptera, and odonata each accounted for 11.11% of the insect visitors. *Nesidiocoris* spp. found as dominant flower visitors in bottle gourd with 37.65 percent contribution. It was followed by *Haptones* spp. (31.76%) and *Aulacophora foveicollis* (9.41%). The maximum activity (30 visits/m²/5 min) of flower visitors was found during the 18:00 hrs of the day while no any activity was observed during 06:00 to 07:00 hrs and 10:00 to 14:00 hrs of the day. The quantitative parameters of yield viz. the number of fruits/plant, percent fruit set, percent malformed fruit, fruit diameter, fruit weight, yield, and yield/ha were maximum in open pollination (5.38, 59.67%, 25.09%, 6.84 cm, 961.24 g, 5.17 kg/plant and 25,836 kg/ha, respectively) compared to pollination with *Apis cerana indica* (5.14, 54.03%, 20.43%, 6.76 cm, 878.57 g, 4.52 kg/plant and 22,607 kg/ha, respectively). No any fruit formation was observed in pollination without insects.

Keywords: Bottle gourd, insects, pollinators, fruit, yield

Introduction

Cucurbits belongs to cucurbitaceous family are one of the most extensively cultivated vegetables in India. It comprises of many species of vine crops with creeping growth habit. Cucurbitacin, a major biochemical compound responsible for bitter taste of cucurbitaceous crops viz. cucumber, bottle gourd and long melon. Bottle gourd (*Lagenaria siceraria* (Molina) Standl.) originated in Africa is one of the most important cucurbits grown in *kharif* and summer season of the year. Its name is derived from its bottle shape variants, also referred as white flower gourd.

Bottle gourd is a robust annual vine that exhibits vigorous growth, with its lush, large leaves and a tendency to either run or climb. The vine branches out and employs tendrils along its stem to support its climbing nature. The flowers are whitish in color with four inches in diameter due to spreading petals pattern. The fruit has an elongated peduncle and is notably large and fleshy, displaying significant variation in terms of shape and size (Stephens, 2018). It starts flowering about 40-50 days after sowing. These flowers are white and possess five sepals and five petals. They bloom during the nighttime, with anthesis occurring between 17:00 to 20:00 hours. Pollen from these flowers remains viable from the day of anthesis until the following morning. The process of transferring pollen from one flower's anther to another flower's stigma is known as pollination, which can be either self-pollination or cross-pollination. Biotic pollinators play a crucial role in the reproductive success of approximately 80% of all flowering plants, and an estimated 75% of the world's crops benefit from biotic pollination. Notably, around one-third of global food production relies on biotic pollinators, with bees being particularly significant in this regard. As the male and female flowers does not occur on the same flowers it mainly relays on insects for the pollination.

Materials and Methods

Experiment area, season and planting material

The study was carried out at college farm, Navsari Agricultural University, Navsari, Gujarat during *Kharif*, 2019. Bottle gourd; cultivar MGH 4 – WARAD, was sown with spacing of 2 m × 1 m in three plot measuring 12 m × 12 m size including three treatments. The plots were kept unsprayed throughout the crop season.

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In the treatments, treatment (T₁) comprised of open pollination means free access to insect pollinators were made available to pollinate the flowers. Treatment (T₂) comprised of pollination without insect means plants were covered with mosquito net 10 m × 6 m × 3 m to prevent the entry of any kind of insect pollinators and treatment (T₃) in which plants were covered with mosquito net and bee pollination was done by placing the healthy colony of honey bees (*A. cerana indica* F.) containing four frames at the 10% flowering.

Diversity of pollinators in bottle gourd

To study the flower visitors of the bottle gourd, an experimental plot was maintained without any insecticidal sprays during the flowering season. Observations were made at one-hour intervals from 06:00 to 18:00 hours, with five-minute observations conducted in each square meter area at five different spots. This was done weekly during the peak flowering period. The collected data were then analyzed by averaging it both in terms of time and groups to draw conclusions about the pollinator fauna and the prevalence of specific visitor groups.

Influence of mode of pollination on the quantitative parameters of bottle gourd

To study the impact of pollination on the yield parameters of bottle gourd in all treatments, three plants were tagged in each

replication and observations were recorded on number of fruits per plant, percent fruit set, percent malformed fruits, diameter of fruit, weight of fruit, yield per plant, yield per hectare and economics. The collected data were analyzed statistically.

Results and Discussion

Flower visitors of bottle gourd in open pollination

The results obtained on various flower visitors of bottle gourd is presented in table 1. The results revealed that total nine species of pollinators were found to be visited on bottle gourd flowers. Among them lepidopterans found dominant (44.44%) comprised of four species viz. *Hippotion celerio*, *Agrius convolvuli*, *Diaphania indica* and *Anadevidia peponis*. It was followed by coleopterans (22.22%) comprised of two species i.e. *Aulacophora foveicollis* and *Haptones* spp. and one species each from hemiptera (*Nesidiocoris* spp.), orthoptera (*Phaneroptera falcata*) and odonata (*Diplacodes trivialis*) contributed 11.11 percent of flower visitors. In past, Morimoto *et al.* (2003) [3] and Subhakar and Sreedevi (2015) [8] both were observed lepidopterans as major flower visitors of the bottle gourd. Thus, the finding of above workers is in accordance with the above researchers. In contrast, Srikanth (2012) [5] noted hymenopterans as major pollinators of bottle gourd.

Table 1: Pollinator fauna of bottle gourd in open pollination

Sr. No.	Order	Family	Species	Total Abundance (%)
1.	Lepidoptera	Sphingidae	<i>Hippotion celerio</i> L.	44.44
2.			<i>Agrius convolvuli</i> L.	
3.		Crambidae	<i>Diaphania indica</i> S.	
4.		Noctuidae	<i>Anadevidia peponis</i> F.	
5.	Coleoptera	Chrysomelidae	<i>Aulacophora foveicollis</i> L.	22.22
6.		Nitidulidae	<i>Haptones</i> spp.	
7.	Hemiptera	Miridae	<i>Nesidiocoris</i> spp.	11.11
8.	Orthoptera	Tettigoniidae	<i>Phaneroptera falcata</i> P.	11.11
9.	Odonata	Libellulidae	<i>Diplacodes trivialis</i> R.	11.11

Foraging activity of insect pollinators of bottle gourd in open pollination

The *Nesidiocoris* spp. was found as the leading flower visitors of bottle gourd constituting 37.65 percent of total flower visitors followed by *Haptones* spp. (31.76%) and *A. foveicollis* (9.41%). The *D. indica*, *H. celerio* and *A. convolvuli* recorded the similar activity with 4.71 percent of flower visitors. The *A. peponis*, *P. falcata* and *D. trivialis* found with 3.52, 2.35 and 1.18 percent flower visitors. The mean activity of flower visitors was recorded in terms of number of visits/m²/5 min. It was found maximum during 18:00 hrs of the day (30 visits/m²/5 min) followed by 08:00 hrs (23 visits/m²/5 min) and 17:00 hrs (12 visits/m²/5 min). The lowest activity was observed during 09:00 hrs of the day (05 visits/m²/5 min) followed by 16:00 hrs and 15:00 hrs (07 visits/m²/5 min and 08 visits/m²/5 min, respectively). There was no any activity of flower visitors was observed during 06:00 to 07:00 hrs and 10:00 to 14:00 hrs of the day. The reason may be that the flowers of bottle gourd closed 08:00 to 20:00 hrs after flowering. Previously, Morimoto *et al.* (2003) [3] observed that hawk moth (*H. celerio* and *A. convolvuli*) and noctuid moth were found as major pollinators of bottle gourd among the all pollinators. Subhakar and Sreedevi (2011) [7] reported that *D. indica* (28.43%) was the predominant pollinator in bottle gourd followed by *H. celerio* (25.73%)

and *Arthoscista hilarialis* (24.65%). They also reported that mean foraging activity of pollinators were higher during 19:00 hrs and 20:00 hrs of the day. Twenty four insect species were found to be visited on cucurbits flowers (Balachandran *et al.*, 2016) [1]. Thus, the preset finding is in accordance with the above researchers. In contrast, Srikanth (2012) [5] noted that hymenopterans were the dominant pollinators in bottle gourd followed by dipterans and lepidopterans. Among them, *A. dorsata* was constituted 23.28 percent of the total insect pollinators.

Influence of pollination by honey bee (*A. cerana indica* F.) on the quantitative parameters of bottle gourd

The perusal data on various yield parameters of bottle gourd were presented in table 3. It indicated that all yield parameters viz. number of fruits per plant, percent fruit set, percent malformed fruit, diameter of fruit, weight of fruit, yield per plant and yield per hectare was found higher in treatment of open pollination (5.38, 59.67%, 25.09%, 6.84 cm, 961.24 g, 5.17 kg/ plant and 25,836 kg/ plant, respectively) compared to pollination with *A. cerana indica* (5.14, 54.03%, 20.43%, 6.76 cm, 878.57 g, 4.52 kg/ plant and 22,607 kg/ha, respectively) while no any fruit formation was observed in plot covered with mosquito net to prevent the entry of any kind of pollinators. Previously, Shwetha *et al.* (2012) [4] in cucumber

and Srikanth (2012) [5] in bottle gourd noted that higher percent fruit set was reported in open pollination compared to other mode of pollination. The maximum percent of malformed cucumber fruit was found in open pollination (20.05%) compared to hand (14.1%) and honey bee (8.05%) pollination (Thakur, M and Rana, 2008) [9]. Hossain *et al.* (2018) [2] recorded in cucumber that percent of malformed fruits (24.35%) was higher in without honey bee pollination.

Regarding to fruit weight, it was observed maximum in open pollination (1619.09 g) compared to honey bee pollination in cucumber (Shwetha *et al.*, 2012) [4]. Srikanth (2012) [5] observed that fruit weight of bottle gourd was maximum in open pollinated plots with attractant compared to open pollination without attractant. Hence, the results on mode of pollination in yield parameters of bottle gourd are in more or less similar with the outcomes of above workers.

Table 2: Activity of various flower visitors on flowers of bottle gourd during the different hours of the day in open pollination

Time (hrs)	Number of visits/m ² /5 min									Total
	<i>A. foveicollis</i>	<i>Nesidiocoris spp.</i>	<i>Haptones spp.</i>	<i>D. indica</i>	<i>H. celerio</i>	<i>P. falcata</i>	<i>A. convolvuli</i>	<i>A. peponis</i>	<i>D. trivialis</i>	
06:00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
07:00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
08:00	00.00	02.00	19.00	00.00	00.00	02.00	00.00	00.00	00.00	23.00
09:00	00.00	05.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	05.00
10:00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
11:00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
12:00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
13:00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
14:00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
15:00	04.00	04.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	08.00
16:00	00.00	07.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	07.00
17:00	02.00	10.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	12.00
18:00	02.00	04.00	08.00	04.00	04.00	00.00	04.00	03.00	01.00	30.00
Mean	0.62	2.46	2.08	0.31	0.31	0.15	0.31	0.23	0.08	6.54
Percentage	9.41	37.65	31.76	4.71	4.71	2.35	4.71	3.52	1.18	100

Table 3: Different yield parameters of bottle gourd affected by mode of pollination

Treatments	No. of fruits/plant	Percent fruit set	Percent malformed fruit	Fruit diameter (cm)	Fruit weight (g)	Yield (kg/plant)	Yield (kg/ha)
T ₁ : Open pollination	5.38	59.67 (50.58)	25.09 (30.06)	6.84	961.24	5.17	25,836
T ₂ : Pollination without insect	00.00	00.00 (00.00)	00.00 (00.00)	00.00	00.00	00.00	00.00
T ₃ : Pollination with <i>A. cerana indica</i>	5.14	54.03 (47.31)	20.43 (26.87)	6.76	878.57	4.52	22,607
S. Em. ±	0.16	1.15	1.48	0.19	28.44	0.21	1069.08
C.D. (p=0.05)	NS	NS	NS	NS	NS	NS	NS
C.V. (%)	7.87	6.23	13.82	6.39	8.18	11.68	11.68

Note: Figure in the parentheses are arc sin transformation value and those outside are retransformed value *figures indicate square root transformed value; NS = Non Significant

Conclusion

The bottle gourd was found to be visited by nine species of pollinators and majority were from lepidopterans. Access to the pollinator fauna is very essential in bottle gourd for the better fruit yield and there was no any fruit formation in absence of pollinators. The impact of bee pollination on fruit yield was found more or less similar compared with open pollination.

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