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Pollinator diversity and abundance in bitter gourd, *Momordica charantia* Linn.

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ABSTRACT: Field studies were conducted at the Department of Entomology, S.V. Agricultural College, Tirupati, India to document the diversity and abundance of insect pollinators on bitter gourd. Fourteen insect species including 6 hymenopterans, 5 lepidopterans and 3 dipterans were recorded visiting the bitter gourd flowers. Among them, *Trigona iridipennis, Halictus gutturosus* and *Apis florea* were the most frequent and abundant visitors. The abundance of *T. iridipennis* was highest (10.83 bees/m^2/5 minutes) followed by *H. gutturosus* (1.06 bees/m^2/5 minutes) and *A. florea* (0.37 bees/m^2/5 minutes). Among all insect visitors, Hymenoptera order constituted the major chunk of pollinators (88.51%) followed by Diptera (5.81%) and Lepidoptera was the least (4.68%). Of total bee population, *T. iridipennis* had the maximum proportion (77.52%) followed by *H. gutturosus* (7.60%). Foraging activity was maximum (9.22-8.17 bees/m^2/5 minutes) at 0900-1000 h of the day. Foraging activity of *T. iridipennis, A. florea* and *H. gutturosus* commenced at 0600, 0630 and 0730 h, respectively with peak at 0900-1000 h and ceased by 1400, 1230 and 1300 h, respectively.

Keywords: *Apis* sp. bitter gourd, pollinator diversity, *Trigona* sp., *Halictus* sp.

INTRODUCTION

Insect pollinators play a crucial role in effecting optimum pollination of many crops thus contributing to both increased productivity and quality. Their essentiality is more significant in crops like Cucurbits, which are monecious (male and female flowers are borne at different positions on the same plant). Bitter gourd (*Momordica charantia* L.) is one of the widely cultivated vegetable crops in Andhra Pradesh. The male to female flower ratio is about 25:1. Long days cause male flowers to bloom up to two weeks before female flowers (Palada and Chang, 2003). Anthesis takes place between 03:30 and 07:30 and stigma remains receptive from 24 h before to 24 h after anthesis and most receptive during early hours of the day (Deshpande *et al*., 1979). The open position of the bitter gourd flowers makes them easy for the pollinators to access and exploit floral rewards. The high male to female ratio achieves the production of sufficient amount of pollen deposits, thus results in effective pollination. A successfully pollinated flower starts to develop fruit on the second to fifth day after it had opened with petals detached, un-pollinated flowers dry up and the ovary turns to yellow on fifth day (Deyto and Cervancia, 2009). The insects of family Apidae are the most reliable agents for pollination. Among members of Apidae family, honey bees are particularly important pollinators as they are capable of carrying pollen, and in the process, the plants visited by them are benefited (Tewari and Singh, 1983). The conservation and management of insect pollinators is gaining importance day by day for which studies on pollinator's diversity, species richness and abundance are essential. Hence, the present investigations have been taken up to generate information about the pollinator diversity and abundance in bitter gourd.

MATERIALS AND METHODS

Field studies were carried out at the Department of Entomology, S.V. Agricultural College, Tirupati from October 2010 to January 2011 to document the diversity and abundance of different insect pollinators of bitter gourd. Sweepings using insect collection nets were made throughout the blooming period at two days intervals during November to January at hourly intervals from morning 0600 to 2000 in the night to collect both diurnal and nocturnal visitors. The collected insects were preserved as dry specimen and got them identified by Dr. C.A. Viraktamath, Emeritus Scientist, Division of Entomology, GKVK, University of Agricultural Sciences, Bangalore.

Abundance of different insect visitors/pollinators of bitter gourd crop was studied during their blooming period. The total number of different insect visitors visiting the gourd flowers in a square metre area (approximately 70-90 flowers) was observed for five minutes at hourly interval, using a hand telly counter and stopwatch following the method given by Free (1993). These observations were started when the plants were in 50 per cent bloom. Later, the studies on foraging ecology was limited to major and frequent insect visitors

in the bittergourd and the mean number per sqmt area for five minutes was recorded at hourly intervals from 0600 to 14.00hrs as the flowers get closed by 14.00h and The documented data was then subjected to ANOVA analysis.

RESULTS AND DISCUSSION

Diversity of insect visitors/pollinators on bitter gourd flowers

The observations on various insect visitors of bitter gourd flowers revealed the presence of only diurnals. The absence of nocturnal activity may be due to complete closure of flowers in bitter gourd. Diurnal insect visitors collected from bitter gourd crop are listed in Table 1. A total of seventeen species belonging to ten families of four orders was recorded from the bitter gourd flowers. The hymenopterans were the major floral visitors comprising of six species belonging to three families. They were *Apis florea* Fab., *Trigona iridipennis* Dal., and *Amegilla zonata* L. (Apidae), *Halictus gutturosus* Vachal., and *Halictus* sp., (Halictidae), *Megachile lanata* Fab. (Megachilidae). Butterflies and moths (five species from three families of lepidoptera) were next in the order of diversity including *Pieris brassicae* Linn., *Delias eucharis* Drury and *Colotis eucharis* Fab. (Pieridae), *Pelopidas mathias* Fab. (Hesperidae) and *Danaus chrysippus* L. (Nymphalidae). The rest belonged to Diptera and Coleoptera (three species from two families) *viz*., *Eristalinus obscuritarsis* de Meijere., *Asarkina* sp. (Syrphidae), *Rhinia* sp. (Rhiniidae) and *Illeis cincta* Fab., *Coccinella transversalis* Fab. (Coccinellidae), *Aulacophora foveicollis* Lucas (Chrysomelidae), respectively.

Among these insects, *T. iridipennis, H. gutturosus* and *A. florea* were the most frequent visitors. The present findings are in conformity with Deyto and Cervancia (2009) who recorded a variety of insect pollinators on bitter gourd belonging to four orders: Hymenoptera (*Apis dorsata*, *A. mellifera*, *Trigona* spp., *Halictus* spp., *Xylocopa* spp. and Formicidae), Lepidoptera (butterflies), Coleoptera (Chrysomelidae) and Diptera (*Calliphora* spp., Sarcophagidae and Syrphidae) and reported, *Trigona* spp., *Halictus* spp. and lepidopterans as the most frequent visitors. In Punjab, Grewal and Sidhu (1978) observed that *Apis florea* and various species of Anthophoridae and Halictidae were the most frequent visitors of bitter gourd flowers with 28, 10 and 5.2 per cent, respectively.

The present studies revealed rich diversity of insect visitors in bittergourd in Tirupati region which may be attributed to supporting flora around nourished at foot hills of Tirumala. Nidagundi and Sattagi (2005) studied the pollinator fauna and foraging activity of honey bees in bitter gourd in Dharwad, Karnataka, India and recorded

Table 1. List of insect visitors/pollinators of *Momordica charantia* flowers at Tirupati

S. No.	Species	Family	Order
1	*Trigona iridipennis* Dal.	Apidae	Hymenoptera
2	*Apis florea* Fab.	Apidae	Hymenoptera
3	*Amegilla zonata* Linn.	Apidae	Hymenoptera
4	*Halictus gutturosus* Vachal.	Halictidae	Hymenoptera
5	*Halictus* sp.	Halictidae	Hymenoptera
6	*Megachile lanata* Fab.	Megachilidae	Hymenoptera
7	*Danaus chrysippus* Linn.	Nymphalidae	Lepidoptera
8	*Pieris brassicae* Linn.	Pieridae	Lepidoptera
9	*Delias eucharis* Drury.	Pieridae	Lepidoptera
10	*Colotis eucharis* Fabricus.	Pieridae	Lepidoptera
11	*Pelopidas mathias* Fab.	Hesperidae	Lepidoptera
12	*Eristalinus obscuritarsis* de Meijere	Syrphidae	Diptera
13	*Asarkina* sp.	Syrphidae	Diptera
14	*Rhinia* sp.	Rhiniidae	Diptera
15	*Illeis cincta* Fab.	Coccinellidae	Coleoptera
16	*Coccinella transversalis* Fab.	Coccinellidae	Coleoptera
17	*Aulacophora foveicollis* Lucas	Chrysomelidae	Coleoptera

as many as 10 species of pollinators of which, 8 species belonged to Hymenoptera and 2 species to Lepidoptera. Shrivastava and Shrivastava (1991) studied 23 species of insects visiting cucurbitacea at Rewa, Madhya Pradesh. They described flowers as bee flowers, butterfly flowers or fly flowers depending on the predominant pollinators. Cervancia and Bergonia (1991) observed that the most common flower visitors of cucumber were *Xylocopa chlorine* (Cockerell), *X. philippinensis* Smith, *Megachile atrata* Smith and *A. dorsata* Fabricius in Philippines. In general, diversity of pollinating insects and species composition varies from region to region and hence the documentation and database generation forms an important component of bioinformatics.

Abundance of insect pollinators

Diurnal per cent contribution to abundance of different bee species on bitter gourd flowers at different hours of the day during November 2010 - January 2011 are depicted in Table 2. The diurnal abundance of different insect visitor species revealed that the total population of *T. iridipennis* (77.52%) was highest followed by *H. gutturosus* (7.60%) and *A. florea* (3.36%) on bitter gourd flowers. All other insect visitors' population was lowest except *Asarkina* sp., *Rhinia* sp. and *Pelopidas mathias* (2.82%, 2.47% and 2.12%, respectively) whose population was moderate among the total population of the insect pollinators. Among all insect visitors, Hymenoptera order alone constituted 87.56% of the total population of the pollinators followed by Diptera (5.81%), Lepidoptera (4.68%) and Coleoptera (1.95%).

The studies on foraging ecology of frequent and abundant insect visitors *viz., T. iridipennis, H. gutturosus* and *A. florea* on *M. charantia* flowers at different hours of the day showed variations in abundance over time (Table 3). No bee population was observed during 1300-1600 h, mainly due to the closure of flower and partially due to the high temperature (>35°C). The mean bee species population over different day hours on bitter gourd flowers ranged from 0.37 (*A. florea*) to 10.83 bees/m^2/5 minutes (*Trigona iridipennis*). For *T. iridipennis*, the maximum bee population was observed at 0900 h (24.41 bees/m^2/5 minutes), followed by 1000 h (21.40 bees/m^2/5 minutes). Irrespective of species, abundance of bees was lowest at 1200-1300 h (1.47-0.01 bees/m^2/5 minutes) and highest at 0900 and 1000 h (9.22 & 8.17 bees/m^2/5 minutes, respectively). Species abundance revealed that *Trigona* sp. dominated the total insect visitors in recording highest mean population

The cumulative mean abundance of important bee species revealed that *Trigona iridipennis* was the most abundant and frequent visitor with a mean population of 10.83 bees/m^2/5 minutes followed by *Halictus gutturosus*

Table 2. Percent abundance of bee species on *M. charantia* flowers during November 2010 – January 2011

Order	Family	Species	Species Abundance (%)	Order Abundance (%)
	Apidae	*Trigona irridipennis* Dal.	75.57	
		Apis florea Fab.	3.36	
		Amegilla zonata Linn	0.29	
Hymenoptera				87.56
	Halictidae	*Halictus gutturosus* Vachal.	7.60	
	Megachilidae	*Megachile lanata* Fab.	0.74	
	Nymphalidae	*Danaus chrysippus* Linn.	0.52	
Lepidoptera	Pieridae	*Pieris brassicae* Linn.	0.95	4.68
		Delias eucharis Drury.	0.70	
		Colotis eucharis Fab.	0.39	
	Hesperidae	*Pelopidas mathias* Fab.	2.12	
Diptera	Syrphidae	*Eristalinus obscuritarsis* de Meijere	0.52	
		Asarkina sp.	2.82	5.81
	Rhiniidae	*Rhinia* sp.	2.47	
Coleoptera	Coccinellidae	*Illeis cincta* Fab.	0.14	1.95
		Coccinella transversalis Fab.	0.38	
	Chrysomelidae	*Aulacophora cincta* Lucas	1.43	

Table 3: Abundance of bee species on *M. charantia* flowers at different hours of the day during November 2010-January 2011

Bee species	Number of bees/m²/5 minutes at different day hours								
	6.00	**7.00**	**8.00**	**9.00**	**10.00**	**11.00**	**12.00**	**13.00**	**Mean**
Trigona iridipennis	1.60 (1.46)	5.17 (2.14)	15.84 (3.89)	24.41 (5.04)	21.40 (4.81)	14.01 (3.65)	4.15 (2.10)	0.00 (1.00)	10.83 (2.94)**
Halictus gutturosus	0.15 (1.06)	0.39 (1.15)	1.42 (1.51)	2.60 (1.85)	2.44 (1.80)	1.20 (1.44)	0.24 (1.11)	0.03 (1.01)	1.06 (1.40)**
Apis florea	0.06 (1.03)	0.31 (1.12)	0.85 (1.29)	0.65 (1.23)	0.69 (1.25)	0.39 (1.14)	0.03 (1.01)	0.00 (1.00)	0.37 (1.16)**
Mean	0.61 (1.18)**	1.96 (1.48)*	6.04 (2.23)**	9.22 (2.63)**	8.17 (2.50)**	5.20 (2.08)**	1.47 (1.41)**	0.01 (1.00)^{NS}	4.08 (1.81)

- Each value represents mean of 25 observations at each sampling time
- Figures in parentheses are "(x+1) transformed values

****: significant at (P<0.01)** ***: Significant at (P<0.05)** **NS: Not significant**

	S.E.(m)	C.D. (p=0.05)	C.D. (p=0.01)
Bee species	0.05	0.14	0.19
Day hours	0.08	0.23	0.30
Bee species × Day hours	0.14	0.40	0.53

(1.06 bees/m²/5 minutes), and *A. florea* was least frequent (0.37 bees/m²/5 minutes) visitor of bitter gourd flowers in the present investigation. This is in agreement with Deyto and Cervancia (2009) who stated that *Trigona* spp., *Halictus* spp. and lepidopterans were the most frequent visitors with five mean daily visits among the different insect pollinators on *M. charantia* in Philippines. In contrary, Nidagundi and Sattagi (2005) reported that among the total visiting pollinators, *Apis florea* was the most predominant species constituting 43.00%, followed by *A. cerana* (26.00%), *A. dorsata* (13.00%) and others (18.00%) and the peak foraging activity of *A. cerana* and *A. dorsata* was observed at 12.00 h with 6.68 and 15.44 bees m^{-2} 5 $minutes^{-1}$, respectively. In Hisar, Hanh (2008) observed that *Ceratina sexmaculata*, *Halictus* sp. and *A. dorsata* were the most abundant insect pollinators visiting cucumber flowers with 2.79, 2.69 and 0.78 bees/m²/5 minutes, respectively. Pateel and Sattagi (2007) recorded that *A. florea*, *A. cerana* and *A. dorsata* were the most frequent insect pollinators visiting the *Rabi* cucumber flowers in Karnataka with 8.03, 6.03 and 3.43 bees/m²/5 minutes, respectively.

The abundance of bees on flowering crops depends on so many factors such as anthesis, weather parameters, competing flora, nests of wild bees in vicinity of the flowering crops, nectar concentration and its volume (Free, 1993). At peak flowering, the availability of flowers is more than commencement and cessation of flowering, and maximum number of insects would visit the crop during this period to increase the pollination process. Therefore, the flower number clearly influences the pollinator abundance, and in turn, the level of pollination. Plants with many flowers often attract more floral visitors than those with fewer flowers (Free, 1993). In the present investigation, a fluctuation in visits of insect pollinators on different days on bitter gourd flowers was observed. The visits were low at the time of commencement and cessation of flowering but these remained high during mid flowering period. This difference might be due to variation in the floral density during the span of blooming and changes in climatic conditions.

This study has revealed the existence of wide and rich pollinator diversity in Tirupati region of Andhra Pradesh. The famous Seven Hills surrounding the study

area might be a perennial habitat facilitating the survival and multiplication of these species, thus helping the agriculturally important crops in the vicinity. Conserving these pollinators with little interference or habitat management is of paramount importance to safeguard the biodiversity of pollinators and at the same time fulfilling the pollination needs of crops.

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