Indian Journal of Entomology 86(1): 230-233 (2024) DoI. No.: 10.55446/IJE.2023.714

POLLINATOR ACTIVITIES IN *MOMORDICA CYMBALARIA* CUCURBITACEAE

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ABSTRACT

Momordica cymbalaria* is an underutilized, non-cultivated cucurbit often seen as a weed. A study to record diversity of pollinators in *M. cymbalaria* was conducted during September to November, 2021 in Virudhunagar (Tamil Nadu). A total of 26 species (18 hymenopterans, 5 dipterans, 2 coleopterans and 1 hemipteran) were found as pollinators. Hymenopterans were the predominant (69.23%; 38.47% solitary bees and 15.38% each of social bees and ants). Dominating pollinators species was *Lasioglossum* sp. >*Dorymyrmex sp. >Technomyrmex albipes*>*Trigona iridipennis* > *Halictus* sp. >*Apis florea.* The mean population of *Lassioglossum* was maximum (6.24 bees/ m^2/ 5 min) during 1000 to 1200 hr. Other solitary and social bees were also foraging maximum during 1000 to 1200 hr. Ants were found frequenting flowers from 0900 to 1800 hr. Species richness was maximum during 1000 to 1200 hr (17 species) and minimum during 1600 to 1800 hr (6 species). Species diversity and evenness not noticed throughout the hours of observation indicated unevenness. Thus, *M. cymbalaria* was mainly pollinated by solitary bees like *Lassioglossum* sp. and to a little extent by *T. iridipennis.

Key words: *Momordica cymbalaria*, Athalakai, pollinators, foraging activity, hymenopterans, solitary bees, *Lassioglossum* sp., *Trigona iridipennis*, *Apis florea*, ants, honey bees, diversity indices, non-cultivated cucurbits

Momordica cymbalaria Hook (Fenzl.) (Cucurbitaceae) is an under-utilized, non-cultivated, season-bound vegetable harvested from wild sources. It is vernacularly called Athalakai (Tamil), Kasarakaee or Kasarakaya or Kasarakai (Telugu), Karchikai (Kannada) and Kadavanchi (Marathi) (Rekha, 2015). Fruits are mainly used for culinary purposes (Parwathi and Kumar, 2002). The plant possesses antioxidant (Prashanth et al., 2013), antidiabetic and hypolipidemic (Rao et al., 1999; Koneri et al., 2006) antihelminthic, antimicrobial (Ramnath and Kumar, 2012) and wound healing properties (Kolluru et al., 2016). Tubers and leaf decoction are widely used in traditional medicine preparations. Fruits have abortifacient properties. Cucurbits being cross pollinated, pollination plays a role in determining the yield (Motzke et al., 2015). The yield of a non-cultivated monoecious cucurbit climber like *M. cymbalaria* varies widely due to pollination gap. Although attention has been given on the pharmacological aspects, its pollination biology remains to be explored. The present study analyses the diversity of pollinators and their pollination biology in *M. cymbalaria.*

MATERIALS AND METHODS

The study was carried out in Erichanatham village, Sivakasi block, Virudhungar District in Tamil Nadu (9°63'25" - 33" N, 77°81'82" - 84" E). Periodical field survey was conducted at weekly intervals during September to November, 2021. The experimental plots were kept free from chemical sprays during the flowering period. The diversity of floral visitors/ pollinators were recorded in five randomly selected $1m^2$ area during flowering period during 0600 - 0800 hr, 0800 - 1000 hr, 1000 - 1200 hr, 1200 - 1400 hr, 1400 - 1600 hr and 1600 - 1800 hr for five min with three replications. The data were later averaged time-wise and group-wise to infer the pollinator fauna as well as the dominance of a particular group. Visual observations on pollen and nectar feeding insects were made and their role in pollination determined. Further, based on their foraging mode pollinators were grouped as side or top workers. Pollinators using their proboscis into the flower were considered as nectar collector while, pollinators carrying pollen load on their hind legs were determined as pollen collectors (Balachandra et al., 2014). Relative abundance, species richness and other diversity indices were computed (Davila et al., 2012). The mean values were square root transformed and compared (LSD, p= 0.05) with AGRES to assess the foraging activity (abundance) of a floral visitor. Pollinator efficiency was calculated based on the relative abundance and foraging activity of an insect species at peak pollinating hours.

Table 1. Foraging activity of pollinators of *M. cymbalaria* at different hours of the day and diversity indices

Pollinators	Foraging Mode*	Feeds on#	No. of individuals/5 min/m²* at indicated hours						
			0600 – 0800	0800 – 1000	1000 – 1200	1200 – 1400	1400 – 1600	1600 – 1800	Mean
Apis cerana indica Apidae: Hymenoptera	T/S	P&N	0.00 (0.70)	0.4 (0.94)^{d}	0.00 (0.70)^{i}	0.00 (0.70)^{h}	0.00 (0.70)^{i}	0.00 (0.70)^{f}	0.067
Apis florea Apidae: Hymenoptera	T/S	P&N	0.00 (0.70)	0.2 (0.83)^{de}	2.87 (1.83)^{d}	1.98 (1.57)^{e}	0.00 (0.70)^{i}	0.00 (0.70)^{f}	0.842
Apis dorsata Apidae: Hymenoptera	T/S	P&N	0.00 (0.70)	0.00 (0.70)^{e}	0.02 (0.83)^{ij}	0.00 (0.70)^{h}	0.00 (0.70)^{i}	0.00 (0.70)^{f}	0
Trigona iridipennis Apidae: Hymenoptera	T/S	P&N	0.00 (0.70)	3.23 (1.93)^{b}	3.86 (2.08)^{bc}	2.02 (1.58)^{e}	0.00 (0.70)^{i}	0.00 (0.70)^{f}	1.518
Lasioglossum sp. Halicitidae: Hymenoptera	T/S	P&N	0.00 (0.70)	5.57 (2.46)^{a}	6.24 (2.59)^{a}	4.5 (2.23)^{ab}	1.46 (1.40)^{cd}	0.48 (0.98)^{d}	3.042
Halictus sp. Halicitidae: Hymenoptera	T/S	P&N	0.00 (0.70)	3.07 (1.88)^{b}	3.22 (1.93)^{cd}	1.73 (1.49)^{e}	0.62 (1.05)^{e}	0.20 (0.83)^{e}	1.473
Amegilla zonata Apidae: Hymenoptera	T/S	P&N	0.00 (0.70)	0.95 (1.20)^{c}	1.67 (1.47)^{e}	0.96 (1.21)^{f}	0.20 (0.83)^{gh}	0.00 (0.70)^{f}	0.63
Nomia sp. Halicitidae: Hymenoptera	T/S	P&N	0.00 (0.70)	0.74 (1.11)^{c}	1.63 (1.45)^{e}	0.98 (1.22)^{f}	0.27 (0.87)^{fg}	0.00 (0.70)^{f}	0.603
Megachile sp. Megachilidae: Hymenoptera	T/S	P&N	0.00 (0.70)	0.43 (0.96)^{d}	1.48 (1.40)^{e}	0.86 (1.16)^{f}	0.32 (0.90)^{fg}	0.18 (0.82)^{e}	0.545
Chrysis sp. Chrysididae: Hymenoptera	T/S	P&N	0.00 (0.70)	0.23 (0.85)^{d}	1.45 (1.39)^{ef}	0.96 (1.20)^{f}	0.46 (0.97)^{ef}	0.00 (0.70)^{f}	0.517
Camponotus pensylvanicus Formicidae: Hymenoptera	T/S	P&N	0.00 (0.70)	0.00 (0.70)^{e}	0.98 (1.21)^{gh}	1.62 (1.45)^{e}	1.22 (1.31)^{d}	0.00 (0.70)^{f}	0.637
Monomorium minimum Formicidae: Hymenoptera	T/S	P&N	0.00 (0.70)	0.24 (0.86)^{d}	1.08 (1.25)^{fg}	3.04 (1.88)^{d}	3.02 (1.87)^{b}	1.67 (1.47)^{c}	1.508
Dorymyrmex sp. Formicidae: Hymenoptera	T/S	P&N	0.00 (0.70)	0.28 (0.88)^{d}	2.85 (1.83)^{d}	4.65 (2.26)^{a}	3.65 (2.03)^{a}	2.85 (1.83)^{a}	2.38
Technomyrmex albipes Formicidae: Hymenoptera	T/S	P&N	0.00 (0.70)	0.28 (0.88)^{d}	3.88 (2.09)^{b}	3.97 (2.11)^{bc}	3.68 (2.04)^{a}	2.47 (1.72)^{b}	2.38
Licilia sp. Calliphoridae: Diptera	S	N	0.00 (0.70)	0.00 (0.70)^{e}	0.60 (1.04)^{i}	0.53 (1.01)^{g}	0.00 (0.70)^{i}	0.00 (0.70)^{f}	0.188
Musca sp. Muscidae: Diptera	S	N	0.00 (0.70)	0.00 (0.70)^{e}	0.63 (1.06)^{hi}	0.46 (0.98)^{g}	0.03 (0.72)^{hi}	0.00 (0.70)^{f}	0.187
Tabanus sp. Tabanidae: Diptera	S	N	0.00 (0.70)	0.00 (0.70)^{e}	0.82 (1.15)^{ghi}	0.36 (0.92)^{g}	0.28 (0.88)^{fg}	0.00 (0.70)^{f}	0.243
Gnats Cecidomyiidae: Diptera	S	N	0.00 (0.70)	0.00 (0.70)^{e}	2.68 (1.78)^{d}	3.46 (1.99)^{cd}	1.63 (1.46)^{c}	0.00 (0.70)^{f}	0.295
S.Ed			-	0.0693	0.0801	0.0730	0.0509	0.0458	
CD (p= 0.05)			-	0.1408	0.1629	0.1485	0.1034	0.0931	
Species richness (S)			0	12	17	16	13	06	
Relative abundance (%)			0	66.67	94.44	88.89	72.22	33.33	
Shannon's diversity index			0	0.43	1.12	1.10	0.91	0.61	
Shannon's evenness index			0	0.40	0.91	0.91	0.82	0.79	
Simpson's diversity index			0	4.60	11.14	10.65	6.57	3.56	
Simpson's evenness index			0	0.38	0.66	0.67	0.51	0.59	

*Each value is a mean of 15 observations; Figures in parentheses square root transformed values; In a column, means followed by same letter(s) on par by LSD (p= 0.05); *T - Top worker; S - Side worker; T/S – Top and side worker; # P- Pollen; N- Nectar

RESULTS AND DISCUSSION

Twenty-six insect species visiting flowers were identified as pollinators. Of all the pollinators, hymenopterans contributed the highest share (18 species; 69.23%) followed by dipterans (5 species; 19.23%), coleopterans (2 species; 7.69%) and a hemipteran (1 species; 3.85%). Solitary bees and wasps were the predominant with 10 species (38.46% share) succeeded by social bees and ants with 4 species each (15.38% share each). Family wise distribution revealed the Apidae as the dominant family (6 species) followed by Formicidae (4 species), and Halictidae (3 species) (Table 1). Species-wise means pooled over hours of observation when compared, solitary bee *Lassioglossum* sp. was found to be the most abundant one followed by ants *Dorymyrmex* sp. and *Technomyrmex albipes,* and social bee *Trigona iridipennis.* This was followed by ant, *Monomorium minimum,* solitary bee *Halictus* sp. and social bee *Apis florea*. The foraging activity started during 0800 - 1000 hr (especially after flowers bloomed at 0930 hr), peaked during 1000 - 1200 hr, and declined thereafter. However, ants' activity were found peaking during 1200 - 1400 hr and their activity continued till 1600 hr- 1800 hr.

The population of *Lassioglossum* increased from 4.5 /m^2/ 5 min (0800 - 1000 hr) to a maximum of 6.24 /m^2/ 5 min (1000 - 1200 hr) followed by a decline (5.57 /m^2/ 5 min; 1200 - 1400 hr). Similar trend was recorded for *T. iridipennis*. All other solitary bees, social bees, and dipterans except gnats were also found foraging maximum during 1000 - 1200 hr. Gnats were found foraging maximum during 1200 - 1400 hr. Ants were found to be the permanent visitors from 0900 - 1800 hr. Thus, the pollinator diversity foraging across hours of observation varied. During 0800 - 1000 hr, solitary bees were the predominant followed by social bees. Ants' activity was found minimal and dipterans were entirely absent. During 1000 - 1200 hr, solitary bees again dominated followed by ants. From 1200 till 1800 hr ants' activity dominated. Ants were the only arthropods frequenting flowers during 1600 - 1800 hr.

Relative abundance (RA) increasing from 0800 - 1000 hr, reached the maximum during 1000 - 1200 hr, and decreased thereafter. During 1600 - 1800 hr least value were observed in accordance with the visual observation of ants alone frequenting more during that time. Similar trend was also noticed in species richness (S) Shannon's diversity indices depicted that both the diversity and abundance of pollinator species were maximum at 1000 - 1400 hr and Shannon's H being 0.91 during 1000 - 1400 hr indicated near evenness of the species during those two hours of observation. However, such diversity and evenness were not noticed during the other hours. Least diversity and evenness (0.43 and 0.40) were recorded during 0800 - 1000 hr followed by 1600 - 1800 hr (0.61 and 0.79). Similar trend was noticed in Simpson's indices.

The results obtained from this study are in accordance with the findings of Subhakar et al. (2013) that *Tetragonula iridipennnis, Halictus guttuorosus* and *Apis florea* were the major pollinators in bitter gourd. Saeed et al. (2012) also recorded the maximum activity of *Apis dorsata, T. iridipennnis* and *Eristalinus laetus* in bitter gourd. Yogapriya et al. (2019a, b) also reported hymenopterans as the major flower visitors/ pollinators and *T. iridipennnis* as a major pollinator of bitter gourd.

Thus, it is clear that the *M. cymbalaria* was mainly pollinated by solitary bees like *Lassioglossum* sp. and to a little extent by social bee *T. iridipennis*. This highlighted the importance of conservation of solitary bees and wild bee colonies. Further, as the diversity and abundance of pollinators was high during 1000 - 1600 hr, spraying insecticides during late evening hours should alone be attempted in the neighbouring crop ecosystems to conserve them.

ACKNOWLEDGEMENTS

We gratefully acknowledge the authorities of Annamalai University for providing the necessary permission and facilitating the successful conduct of this research.

AUTHOR CONTRIBUTION STATEMENT

YA and ST designed the research. YA conducted the experiment and analyzed the data. ST made correction in the monograph.

CONFLICT OF INTEREST

No conflict of interest.

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(Manuscript Received: August, 2022; Revised: December, 2022;
Accepted: January, 2022; Online Published: January, 2023)
Online First in www.entosocindia.org and indianentomology.org Ref. No. e22714