



# Diversity, Abundance and Diurnal Activity of Insect Pollinators on Onion (*Allium cepa*) in Northern Transitional Zone of Karnataka

Chava Asritha, D.N. Kambrekar<sup>1</sup>, Subhash B. Kandakoor<sup>2</sup>, S.M. Hiremath<sup>3</sup>  
Ramesha N.M. and Methuku Anil Kumar

Department of Entomology, University of Agricultural Sciences, Dharwad-580 005, India

<sup>1</sup>ICAR-KVK, University of Agricultural Sciences, Dharwad-580 005, India

<sup>2</sup>ARS, Bailhongal, University of Agricultural Sciences, Dharwad-580 005, India

<sup>3</sup>Department of Horticulture, University of Agricultural Sciences, Dharwad-580 005, India

E-mail: [chavaasritha@gmail.com](mailto:chavaasritha@gmail.com)

**Abstract:** The study on insect pollinators of onion (*Allium cepa*) recorded 16 species from 11 families across four orders, with hymenopterans being the dominant group (94.2%), followed by Diptera (3.1%), Lepidoptera (1.4%), and Coleoptera (1.3%). Among honeybees, *Apis florea* was the most abundant pollinator (34.65%), followed by *Tetragonula* sp. (30.84%). Pollinator activity peaked at 1000-1100 h, increasing with flowering progression from 50% to 90%. Maximum activity (7.73 visitors/m<sup>2</sup>/5 min) occurred at 90% flowering. Diversity indices indicated higher species richness at 90% flowering (Shannon-Wiener index: 1.81; Simpson diversity: 0.81) compared to 50% flowering (Shannon-Wiener index: 1.67; Simpson diversity: 0.77). The findings highlight the significance of hymenopterans as primary pollinators. This study emphasizes the critical role of diverse insect pollinators in onion crop productivity, with peak pollination activity occurring during mid-morning hours.

**Keywords:** Diversity, Hymenopterans, Onion, Pollinator activity

Onion, *Allium cepa* L., is a well-known bulbous vegetable from Central Asia and part of the Liliaceae family. For over 5000 years. In terms of onion bulb production, India ranks second after China, producing 311.29 lakh tonnes with a productivity rate of 16.26 MT/ha (Anonymous 2022). Despite the high production levels, the average yield of onions in India falls below the global standard. This disparity is primarily due to the lack of quality seed material. India requires 9400 tonnes of onion seeds each year to cultivate the 11.73 lakh ha area. About 40% of the onion seed demand is fulfilled by the organized sector, while farmers supply the remaining. The quality of onion seeds is closely linked to pollination, which depends on the number and variety of insect pollinators. Hence, it is crucial to protect these insect visitors to ensure the production of high-quality and abundant onion seeds.

Onion is a crop that experiences a high degree of cross-pollination due to its protandrous characteristics (Kavitha and Rami Reddy 2018). Self-pollination is uncommon, and the plant depends on insects for cross-pollination (Karuppiyah et al., 2017). The umbelliferous inflorescence can be seen at the apex of the hollow green stalk (Kavitha and Rami Reddy 2018). Various factors influence the number of insect visitors to onion flowers, including their size, shape and colour, along with environmental conditions and the availability of floral rewards. The pollen and nectar produced by onion blooms attract a range of insect visitors, such as honey bees, syrphid flies, drone flies, halictid bees, butterflies, and bumblebees (Sajjad et al., 2008). Various pollinators have been identified

as significant contributors in different ecological regions around the globe. Stingless bees (Karuppiyah et al., 2017) and honey bees of the genus *Apis*, namely *A. dorsata* (Devi et al., 2014, Saeed et al., 2008), *A. cerana indica* (Hosamani et al., 2019), *A. mellifera* (Mazeed et al., 2018) and *A. florea* (Saeed et al., 2008), along with syrphids (Chandel et al., 2004) are noted for their effectiveness as pollinators in the onion ecosystem due to their body size, morphology, and short tongue (Pusphpalatha et al., 2023). Onion plants fail to produce quality seeds without insect visitation to their flowers. Research has been carried out to assess the abundance of various natural pollinators and the impact of bee pollination on the quantity and quality of onion seeds. In India, the population of natural insect pollinators is rapidly declining due to the ongoing use of pesticides and the loss of natural habitats. For instance, in crops like sunflowers, there is a 30 per cent reduction in flower-visiting insects (Chaudhary and Poonia 2018). The current study examined the diversity of different insect pollinators on onion crop within the Dharwad region of Karnataka.

## MATERIAL AND METHODS

The present investigations were carried out in the Saidapur farm, University of Agricultural Sciences, Dharwad (15°26' North latitude, 75°07' East longitudes and at an altitude of 678 meters above mean sea level) during *Rabi* 2021-22. The experimental area is located in the Northern transitional zone (zone VIII) of Karnataka, which receives

700-800 mm average annual rainfall. The temperature and relative humidity range from 12-37 °C and 40 to 85 per cent respectively.

The bulbs of the onion variety 'Bhima super' were planted on 10<sup>th</sup> November 2021. The crop came to bloom by the end of February 2022. The experimental plot was raised as per the package of practices except for plant protection measures during the flowering period. Different species of insect pollinators visiting the umbels of the onion crop were observed. The visual count was done in onion under open pollination conditions. Randomly, five spots of one square meter area were selected and observed for 2 minutes at different time intervals of 0800-0900 h, 1000- 1100 h, 1300-1400 h and 1600-1700 h at 50, 75 and 90 per cent flowering. During the period of observation, Samples collected were placed in ethyl acetate as the killing agent, pinned, preserved and identified by the taxonomical expert of the Division of Entomology, Dr. Yeshwanth, GKVK, Bangalore.

The relative abundance of pollinators was calculated.

$$\text{Relative abundance} = \frac{\text{Abundance of the species}}{\text{Total abundance of all species}} \times 100$$

Shannon-Wiener diversity index (H):

$$H = -\sum p_i \ln p_i$$

Where,

$p_i$  = Proportion of the  $i^{\text{th}}$  species of pollinator

$\ln$  = Natural log with base  $e=2.718$

Simpson index of diversity (1-D):  $D = 1 - \sum p_i$

### RESULTS AND DISCUSSION

The insect pollinators on onion include 16 species belonging to 11 families of 4 orders. The hymenopterans were the most abundant insect pollinators (94.20%) followed by Diptera, Lepidoptera and Coleoptera. The relative abundance of *Apis florea* was highest (34.65%) followed by *Tetragonula* sp. *A. cerana indica* and *A. dorsata*. Among the Dipterans, two syrphid species, *Phytomia errans* (2.64%) and *Ischidon scutellari* (0.43 %) were recorded. Other insects *Chrysomia bezziana* *Oplodontha viridula*, *Scolia* sp., *Delta* sp., *Luthrodes pandava* (Horsfield), *Danaus chrysippus*, *Euchromia polymena*, *Aulacophora foveicollis*, *Coccinella transversalis* and *Cheilomenes sexmaculata* (Plate 1, 2) activity was frequent and rare during the cropping season (Table 1).

Onion flowers are rich in pollen and nectar content which attracted the pollinators. While hopping from plant to plant in quest of their prey, coccinellid species may accidentally act as pollinators. Lepidopterans that feed on nectar while visiting flowers regularly also serve as pollinators. The pollinator fauna of onion has been well documented by several workers in different parts of the country. Basavaraj

(2004) reported that Hymenopteran pollinators accounted for the majority (90.15%) followed by Diptera (6.63%) Lepidoptera (1.70%) and other pollinators (1.52%) in onion. TAbrol (2010) identified *A. florea* as the key pollinator species. Hymenopterans comprised 60 per cent of pollinators followed by Diptera, Lepidoptera and Coleoptera (Devi et al., 2014). Karuppaiah et al. (2018) revealed that onion was pollinated by eleven different insect species where Hymenopterans contributed 98 per cent. Hosamani et al. (2019) observed that most of the pollinators on onion were Hymenopterans (87.79%), followed by Dipterans, and Lepidopterans. Four species of honeybees from the Apidae family made up the majority of pollinators that visited the

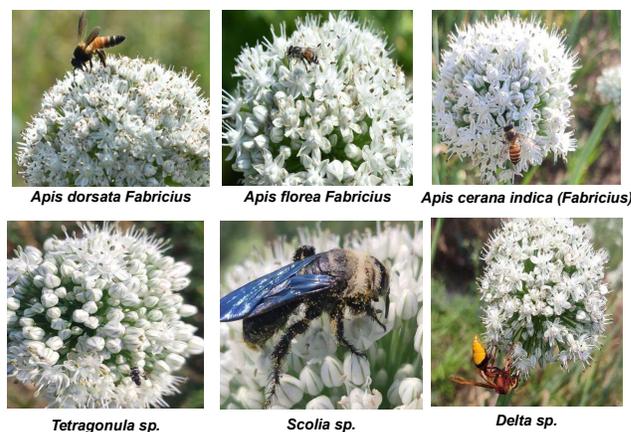


Plate 1. Hymenopteran pollinators

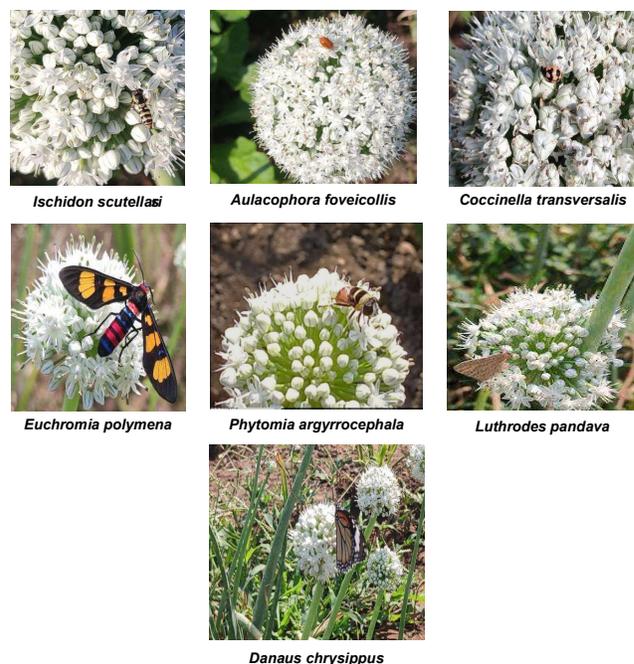


Plate 2. Pollinators recorded on onion

onion crop. Maragoor et al. (2022) further validated that *A. florea* is the primary pollinator, followed by *A. cerana indica* and syrphids in the coriander and ajwain ecosystems of Northern Karnataka.

Pollinator activity peaked at 1000-1100 h (4.78 visitors/m<sup>2</sup>/5 min) and lowest at 0800-0900 h (1.80 visitors/m<sup>2</sup>/5 min) at 50 per cent flowering under open pollination conditions. Pollinator activity was moderate between 1300-1400 h (3.63 visitors/m<sup>2</sup>/5 min) and 1600-1700 h (2.78 visitors/m<sup>2</sup>/5 min). The most prevalent pollinators that were active across all observational periods were Hymenopterans. Between 1000-1100 h, *Tetragonula* sp. (7.75 visitors/m<sup>2</sup>/5 min) and *A. florea* (8.75 visitors/m<sup>2</sup>/5

min) were the two most active pollinators, while lepidopteran activity was minimal ranging between 0.00 and 0.4 visitors/m<sup>2</sup>/5 min (Table 2). At 75 per cent flowering, pollinator activity was maximum (6.2 visitors/m<sup>2</sup>/5 min) between 1000-1100 h and was lowest (2.3 visitors/m<sup>2</sup>/5 min) at 0800-0900 h. It was moderate between 1300-1400 h (4.93 visitors/m<sup>2</sup>/5 min) and 1600-1700 h (3.63 visitors/m<sup>2</sup>/5 min). Hymenopterans were the most common pollinators active at all intervals observed. Maximum number of *A. florea* and *Tetragonula* sp., was recorded from 1000 to 1100 hours (15.4, 13.4, visitors/m<sup>2</sup>/5min respectively). Among these, *A. florea* was the dominant pollinator (11.1 visitors/m<sup>2</sup>/5 min), followed by *Tetragonula* sp. (9.15 visitors/m<sup>2</sup>/5 min), while

**Table 1.** Diversity of insect pollinators on onion

Common name	Scientific name	Family	Order	Species abundance (%)	Relative abundance % (Order)
Little bee	<i>Apis florea</i>	Apidae	Hymenoptera	34.65	94.20
Indian bee	<i>A. cerana indica</i>			15.11	
Rock bee	<i>A. dorsata</i>			13.10	
Stingless bee	<i>Tetragonula</i> sp.			30.84	
Scoliid wasp	<i>Scolia</i> sp.	Scoliidae		0.47	
Potter wasp	<i>Delta</i> sp.	Vespidae		0.03	
Syrphid	<i>Phytomia errans</i>	Syrphidae	Diptera	2.64	3.10
Common hoverfly	<i>Ischidon scutellaris</i>			0.43	
Common green colonel	<i>Oplodontha viridula</i>	Stratiomyidae		0.02	
Blow fly	<i>Chrysomia</i> sp.	Calliphoridae		0.01	
Plain cupid	<i>Luthrodes pandava</i> (Horsfield)	Lycaenidae	Lepidoptera		1.40
Plain Tiger Butterfly	<i>Danaus Chrysippus</i>	Nymphalidae			
Wasp moth	<i>Euchromia polymena</i>	Erebidae			
Red pumpkin beetle	<i>Aulacophora foveicollis</i>	Chrysomelidae	Coleoptera		1.30
Transverse ladybird	<i>Coccinella transversalis</i>	Coccinellidae			
Indian wave striped ladybug	<i>Cheilomenes sexmaculata</i>				

**Table 2.** Diurnal variation in activity of pollinators at different hours at 50 per cent flowering in onion

Species	Number of visitors/m <sup>2</sup> /5 minutes					Total	Mean±SD
	08.00-09.00 h	10.00-11.00 h	13.00-14.00 h	16.00-17.00 h			
<i>A. florea</i>	5.4	12.6	9.4	7.6		35	8.75 ±3.04
<i>A. cerana indica</i>	2.0	5.0	3.4	2.8		13.2	3.3±1.27
<i>A. dorsata</i>	1.6	5.6	4.2	3.6		15	3.75 ±1.66
<i>Tetragonula</i> sp.	4.6	11.2	9.0	6.2		31	7.75 ± 2.93
<i>P. errans</i>	0.4	1.6	1.2	0.8		4	1±0.52
<i>I. scutellaris</i>	0.2	1.4	1.0	0.6		3.2	0.8±0.52
Lepidopterans	0.0	0.4	0.2	0.4		1	0.25±0.19
Others	0.2	0.4	0.6	0.2		1.4	0.35±0.19
Total	14.4	38.2	29	22.2		103.8	26±10.11
Mean	1.80	4.78	3.63	2.78		12.97	3.24

other pollinators activity was low (Table 3). Activity of pollinators at 90 per cent flowering was maximum between 1000-1100 h (7.73 visitors/m<sup>2</sup>/5 min) and minimum between 0800-0900 h (3.6 visitors/m<sup>2</sup>/5 min), while it was moderate between 1300-1400 h (6.3 visitors/m<sup>2</sup>/5 min) and 1600-1700 h (4.7 visitors/m<sup>2</sup>/5 min). Hymenopterans were the most predominant pollinators, which were active throughout the day. However, the maximum number of *A. florea* and *Tetragonula* sp was during 1000-1100 h (18.6, 16.8, visitors/m<sup>2</sup>/5 min respectively). *A. florea* was the dominant pollinator (14.00 mean visitors/m<sup>2</sup>/5 min), followed by *Tetragonula* sp. (12.3 visitors/m<sup>2</sup>/5min), while the activity of other pollinators was less and ranged from 0.2 to 0.8 visitors/m<sup>2</sup>/5min (Table 4). As there is an increase in flowering from 50 per cent towards 90 per cent, the activity of pollinators also increased in onion. Within a day, the activity of most of the pollinating species was maximum at 1000-1100 h (Fig.1). Hymenopterans were the most common

pollinators, which were active at all observation intervals. Among the honeybees, *A. florea* was the most predominant pollinator, followed by *Tetragonula* sp. and peak activity was d during 1000-1100 h. The current findings are in accordance with the previous findings. The rate of pollinator visitation was notably high, peaking at 1000 hours for onion, aligning with observations made by Saleh et al. (2021). The maximum abundance of *A. florea* was recorded between 1200 and 1400 hours. In this study, the highest visitation rates for onions were observed during the intervals of 1000-1100 hours and subsequently from 1300-1400 hours, likely influenced by variations in climatic conditions. Conversely, in coriander, peak visitation was noted during the 1000-1100 hours interval, as documented by Bhowmik et al. (2017), and another report indicated highest visitation between 1000 and 1200 hours in coriander (Usman et al., 2018) and onion (Biradar et al., 2017).

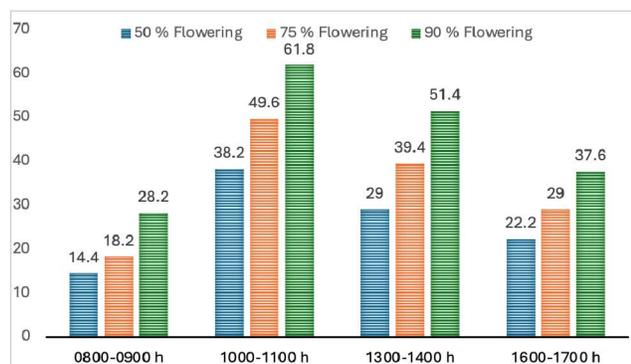
Among the different flowering stages (50, 75 and 90 %),

**Table 3.** Diurnal variation in activity of pollinators at different hours at 75 per cent flowering in onion

Species	Number of visitors/m <sup>2</sup> /5 minutes				Total	Mean±SD
	08.00-09.00 h	10.00-11.00 h	13.00-14.00 h	16.00-17.00 h		
<i>A. florea</i>	6.2	15.4	12.8	10.0	44.4	11.1±3.94
<i>A. cerana indica</i>	2.8	7.2	5.6	4.0	19.6	4.9±1.91
<i>A. dorsata</i>	2.0	7.0	5.2	3.6	17.8	4.45±2.14
<i>Tetragonula</i> sp.	5.2	13.4	10.6	7.4	36.6	9.15±3.59
<i>P. errans</i>	1.0	2.8	2.2	1.6	7.6	1.9±0.77
<i>I. scutellaris</i>	0.6	2.6	2.0	1.2	6.4	1.6±0.87
Lepidopterans	0.2	0.6	0.4	0.8	2	0.5±0.26
Others	0.2	0.6	0.6	0.4	1.8	0.45±0.19
Total	18.2	49.6	39.4	29	136.2	34.05±13.50
Mean	2.3	6.2	4.93	3.63	17.03	4.26±1.67

**Table 4.** Diurnal variation in activity of pollinators at different hours at 90 per cent flowering in onion

Species	Number of visitors/m <sup>2</sup> /5 minutes				Total	Mean±SD
	08.00-09.00 h	10.00-11.00 h	13.00-14.00 h	16.00-17.00 h		
<i>A. florea</i>	9.4	18.6	16.8	11.2	56	14±4.39
<i>A. cerana indica</i>	5.4	9.8	7.2	6.0	28.4	7.1±1.95
<i>A. dorsata</i>	2.6	8.6	6.0	4.8	22	5.5±2.50
<i>Tetragonula</i> sp.	7.6	16.8	15.0	9.8	49.2	12.3±4.31
<i>P. errans</i>	1.8	3.2	2.8	2.2	10	2.5±0.62
<i>I. scutellaris</i>	1.4	3.0	2.6	2.0	9	2.25±0.7
Lepidopterans	0.4	1	0.6	0.8	2.8	0.7±0.26
Others	0.2	0.8	0.4	0.8	2.2	0.55±0.3
Total	28.8	61.8	51.4	37.6	179.6	44.9±14.61
Mean	3.6	7.73	6.43	4.7	22.45	5.61±1.83



**Fig. 1.** Diurnal variation in activity of pollinators at different flowering stages of onion

**Table 5.** Diversity indices of pollinators at different flowering stages in onion

Stages of flowering	50 %	75 %	90 %
Shannon-Wiener index (H)	1.67	1.78	1.81
Simpson index of diversity (1-D)	0.77	0.79	0.81

diversity indices (H and 1-D) of pollinators in onion were higher during 90 per cent flowering, followed by 75 per cent and 50 per cent flowering. The Shannon wiener index (H) ranged from 1.67 to 1.81 at 50% and 90% flowering. Simpson index of diversity (1-D) ranged from 0.77 at 50 per cent flowering to 0.81 at 90 per cent flowering (Table 5). At 50 per cent flowering, the Shannon wiener index (H) was lowest (1.67) and highest (1.81) at 90 per cent flowering. Simpson index of diversity (1-D) was lowest (0.77) at 50 per cent and maximum (0.81) at 90 per cent flowering. (Table 5). The diversity indices (H and 1-D) of insect pollinators in onion were higher at 90 per cent flowering, followed by 75 and 50 per cent because the availability of pollen and nectar content increased towards peak flowering following an increase in the density and diversity of pollinators. Shannon-Weiner index of 1.805 in onion was reported by Karuppaiah et al. (2018), which supports the present findings.

### CONCLUSION

The Hymenopterans, especially *Apis florea* and *Tetragonula* sp., are the primary pollinators for onion crop in Dharwad region. Pollinator activity reaches its highest point between 10:00 and 11:00 AM, and increases as the flowers develop from 50% to 90% blooming, with the greatest diversity indices recorded at the 90% flowering stage. These results emphasize the vital role of insect pollinators, particularly honeybees, in onion cultivation.

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### AUTHOR'S CONTRIBUTION

CA performed the experiment, captured and prepared the original manuscript. KDN conceptualised the research SBK and HSM reviewed and corrected the manuscript. RNM analysed the data.

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