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Studies on foraging behaviour of Non-*Apis* insect pollinators visiting on mustard and coriander crops

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Abstract

The present experiment on foraging behaviour of Non-*Apis* insect pollinators visiting on mustard and coriander crops was conducted at Instructional cum Research Farm, CARS, Bemetara (C.G.) during the academic year of 2022-2023. Among the non *Apis* insect pollinators *Erisyrphus sp.* (13.35%), *Eristalis tenax L.* (11.84%), *Eristalinus sp.* (10.93%), and *Ceratina sp.* (9.71%) were recorded the most frequent visitors while, *Spathulina acroleuca* (0.61%) was noted as having a comparatively lower abundance. Among total abundance of the non *Apis* insect pollinators, order Diptera (44.01%) constituted major fraction of pollinator group followed by Hymenoptera (32.47%). In coriander flowers *Eristalis tenax L.* (20.50%), *Erisyrphus sp.* (19.82%), *Rhynchium sp.* (10.59%), and *Xylocopa fenestrata Fab.* (9.01%) were the most frequent visitors, while *Euploea core* (1.35%) visits the coriander flowers less frequently. Among non *Apis* insect pollinators order Diptera was the most dominant and most frequent visitors constituted 46.85 per cent of total abundance followed by order Hymenoptera (25.91%).

Keywords: Pollinators, abundance, flowers, dominant, visitors

Introduction

In the higher plants sexual reproduction and perpetuation of species are brought about through pollination. There are several insect pollinators involve actively in pollination on different crops as visiting for pollen and nectar collection. Insect pollinators increase not only yield but also helps in increasing the hybrid vigour, creating variation and maintaining the gene flow in the ecosystem, there by conserving the crop varietal diversity. Adequate pollination of crops thus contributes to both increased productivity and quality. The yields of agricultural crops can be significantly increased through good management practices, including effective pollination (Melnichenko, 1977) [5].

Indian mustard (*Brassica juncea L.*) is one of the most important oilseed crops in our country. India is one of the major producer of mustard in the world. In India, it is cultivated in Rajasthan, Uttar Pradesh, Madhya Pradesh, Haryana, Punjab, Gujarat, West Bengal, Chhattisgarh, Bihar, Jharkhand and several other states (Shekhawat, 2012) [8]. Mustard is self-incompatible with 100 per cent entomophilous cross-pollination.

Coriander (*Coriandrum sativum Linn.*) is an annual herb belonging to the family Umbelliferae, grown widely in India, mainly for its leaves and seeds which have a fragrant odor and pleasant aromatic taste which are a key ingredient in numerous dishes worldwide (Mane, 2003) [3]. Coriander crop is highly cross-pollinated in nature, allowing a large population of insect pollinators during flowering for their pollination. The flower fragrance of coriander is attractive due to nectar which attracts the nectar feeding insect (Meena *et al.*, 2015) [4].

Foraging behavior is one of the most important parameter in successful cross-pollination and it is variable from one pollinator species to other, even within the species.

Materials and Methods

The experiment was carried out with mustard variety Chhattisgarh sarson -1 and Coriander variety Chhattisgarh Dhaniya.

S. No.	Common Name	Scientific Name	Cultivar	Spacing (cm)
1	Mustard	<i>Brassica juncea (L.) Czern</i>	Chhattisgarh sarson -1	45 × 15 cm.
2	Coriander	<i>Coriandrum sativum L.</i>	Chhattisgarh dhaniya	20 × 15 cm.

The crops were grown under normal agronomical package of practices except the insecticidal control measures. Observations were recorded on different species of insect pollinators visiting the mustard and coriander crops during flowering. The relative abundance of different group of insect pollinators were recorded visually at different hours (08:00-10:00, 12:00-14:00 and 15:00-17:00 hours) of the day at weekly intervals. The observation was taken as count the number of insect pollinators from randomly selected 1m² area with a duration of 10 minutes. Five such places were selected randomly for taking insect counts. Observation was started from 10 per cent after commencement of the flowering.

Results and Discussion

Abundance of different non *Apis* insect pollinators/visitors in mustard crops: Insect visitors documented from mustard crop revealed that a total of 18 species belonging to fourteen families of five orders were recorded from the mustard flowers (Table 1). Among the non *Apis* insect pollinators Dipterans were the major floral visitors comprising 5 species

from three families viz., *Erisyrphus sp.*, *Eristalis tenax* L., *Eristalinus sp.* (Syrphidae), *Musca domestica* L (Muscidae), *Spathulina acroleuca* S. (Tephritidae). They were followed by Hymenoptera which comprised 5 species from four families viz., *Ceratina sp.*, *Xylocopa fenestrata* Fab. (Apidae), *Rhynchium sp.* (Spinola) (Vespidae), *Camponotus compressus* Fab. (Formicidae) and *Helictes sp.* (Halictidae). Coleoptera included 3 species from two families viz., *Coccinella transversalis* Fab, *Coccinella septumpunctata* L. (Coccinellidae), *Monolepta signata* (Chrysomelidae). Lepidoptera comprised 3 species from three family viz., *Danaus plexippus* L. (Nymphalidae), *Amata cyssea* S. (Erebidae) and *Papilio demolius* L. (Papilionidae). Hemiptera comprised 2 species from two families viz., *Dysdercus cingulatus* (Pyrrhocoridae), and *Nezara viridula* L (Pentatomidae). In present experiment among the non *Apis* insect pollinators *Erisyrphus sp.*, *Eristalis tenax* L., *Eristalinus sp.* and *Ceratina sp.* were recorded the most frequent visitors. The results obtained were presented in Table 1.

Table 1: List of non *Apis* insect pollinators/visitors of Mustard crop

S. No.	Common Name	Scientific Name	Family	Order
1.	Carpenter bee	<i>Xylocopa fenestrata</i> Fab.	Apidae	Hymenoptera
2.	Small carpenter bee	<i>Ceratina sp.</i>		
3.	Black ants	<i>Camponotus compressus</i> Fab.	Formicidae	
4.	Vespid wasp	<i>Rhynchium sp.</i> (Spinola)	Vespidae	
5.	Sweat bee	<i>Helictes sp.</i>	Halictidae	
6.	Hoverfly	<i>Eristalis tenax</i> L.	Syrphidae	Diptera
7.	Marmalade hoverfly	<i>Erisyrphus sp.</i>		
8.	Lagoon fly	<i>Eristalinus sp.</i>		
9.	House fly	<i>Musca domestica</i> L.	Muscidae	
10.	Spathulina fly	<i>Spathulina acroleuca</i> S.	Tephritidae	
11.	Monarch butterfly	<i>Danaus plexippus</i> L.	Nymphalidae	Lepidoptera
12.	Lemon butterfly	<i>Papilio demolius</i> L.	Papilionidae	
13.	Tiger moth	<i>Amata cyssea</i> S.	Erebidae	
14.	Flea beetle	<i>Monolepta signata</i>	Chrysomelidae	Coleoptera
15.	Six spotted lady bird beetle	<i>Coccinella transversalis</i> Fab.	Coccinellidae	
16.	Ladybird beetle	<i>Coccinella septumpunctata</i> L.		
17.	Red cotton bug	<i>Dysdercus cingulatus</i>	Pyrrhocoridae	Hemiptera
18.	Green stink bug	<i>Nezara viridula</i> L.	Pentatomidae	

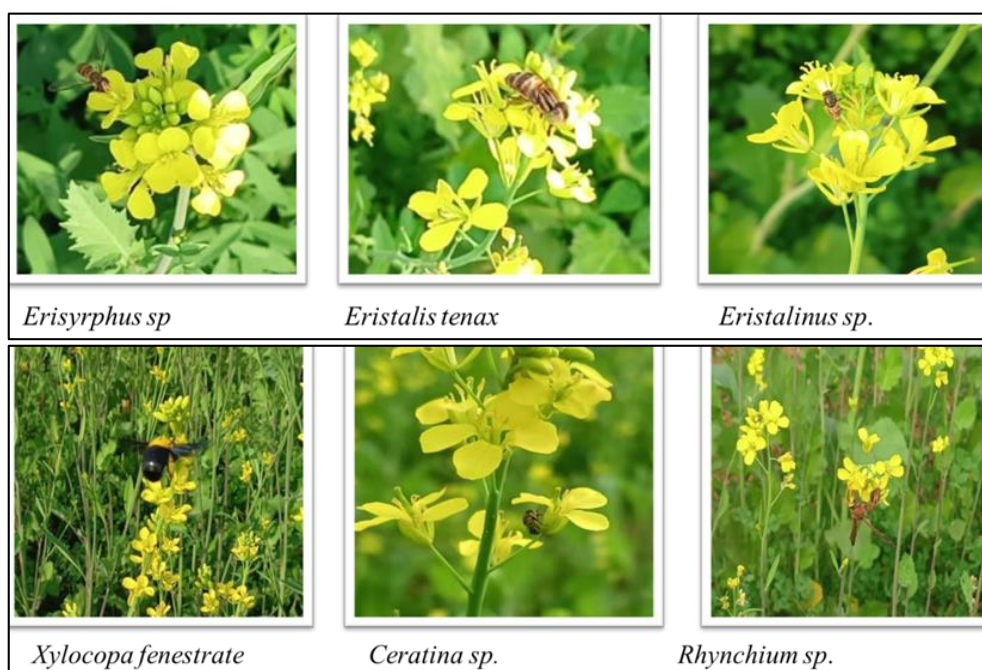


Fig 1: Different species of insect pollinators visiting in mustard flowers

Relative abundance of non *Apis* Insect pollinators/visitors in mustard

The non-*Apis* insect pollinators, specifically the Diptera order (44.01%), constituted a substantial portion of the pollinators group in terms of total abundance. followed by Hymenoptera (32.47%), Coleoptera (10.63%), Lepidoptera (6.53%), and

Hemiptera (6.36%) (Table 2). Among the non *Apis* insect pollinators *Erisyrphus sp.* (13.35%), *Eristalis tenax L.* (11.84%), *Eristalinus sp.* (10.93%), and *Ceratina sp.* (9.71%) were recorded the most frequent visitors, while *Spathulina acroleuca* (0.61%) was recorded visiting the mustard flowers less frequently (Table 2).

Table 2: Relative abundance of non *Apis* Insect visitors/pollinators in mustard

Order	Family	Species	Species abundance (%)	Order abundance (%)
Hymenoptera	Apidae	<i>Xylocopa fenestrata</i> Fab.	8.04	32.47
		<i>Ceratina sp.</i>	9.71	
	Formicidae	<i>Camponotus compressus</i> Fab.	3.64	
	Vespidae	<i>Rhynchium sp.</i> (Spinola)	7.59	
	Halictidae	<i>Helictes sp.</i>	3.49	
Diptera	Syrphidae	<i>Eristalis tenax</i> L.	11.84	44.01
		<i>Erisyrphus sp.</i>	13.35	
		<i>Eristalinus sp.</i>	10.93	
	Muscidae	<i>Musca domestica</i> L.	7.28	
	Tephritidae	<i>Spathulina acroleuca</i> S.	0.61	
Lepidoptera	Erebidae	<i>Amata cyssea</i> S.	1.82	6.53
	Papilionidae	<i>Papilio demolius</i> L.	1.67	
	Nymphalidae	<i>Danaus plexippus</i> L.	3.04	
Coleoptera	Chrysomelidae	<i>Monolepta signata</i>	2.43	10.63
	Coccinellidae	<i>Coccinella transversalis</i> Fab.	4.86	
		<i>Coccinella septumpunctata</i> L.	3.34	
Hemiptera	Pyrrhocoridae	<i>Dysdercus cingulatus</i>	4.39	6.36
	Pentatomidae	<i>Nezara viridula</i> L.	1.97	
Total				100.00

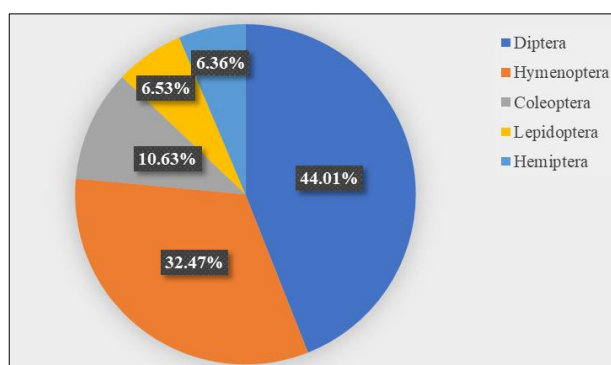


Fig 2: Relative abundance of non *Apis* Insect visitors/pollinators in mustard

Studies of Mudssar Ali *et al.* (2011) [1], reported that 35 species of insect pollinators belonging to 3 orders of 14 families were recorded on *Brassica napus* L. in Pakistan. Mohapatra *et al.* (2011) [6], recorded that besides honey bees, syrphid and unidentified dipteran flies were the most dominant group of foragers in mustard flowers.

Among the non *Apis* insect pollinators all the dipterans (five species) and lepidopterans (three species) were found as only nectar forager. Among the five species of hymenopteran visitors of mustard flowers, four species were found as pollen foragers and nectar foragers and one species as only nectar foragers. Coleoptera (three species), and Hemiptera (two species) were found as casual visitors of the Mustard flowers (Table 3).

Table 3: Foraging preference of non-*Apis* insect pollinators/visitors on Mustard flower

S. No.	Name of the species	Order	Family	Pollen foragers (PF)	Nectar foragers (NF)	Casual visitors (CV)
1	<i>Xylocopa fenestrata</i>	Hymenoptera	Apidae	PF	NF	
2	<i>Ceratina sp.</i>	Hymenoptera	Apidae	PF	NF	
3	<i>Rhynchium sp.</i>	Hymenoptera	Vespidae	PF	NF	
4	<i>Helictes sp.</i>	Hymenoptera	Halictidae	PF	NF	
5	<i>Camponotus compressus</i>	Hymenoptera	Formicidae		NF	
6	<i>Eristalis tenax</i>	Diptera	Syrphidae		NF	
7	<i>Erisyrphus sp.</i>	Diptera	Syrphidae		NF	
8	<i>Eristalinus sp.</i>	Diptera	Syrphidae		NF	
9	<i>Musca domestica</i>	Diptera	Muscidae		NF	
10	<i>Spathulina acroleuca</i>	Diptera	Tephritidae		NF	
11	<i>Amata cyssea</i>	Lepidoptera	Erebidae		NF	
12	<i>Papilio demolius</i>	Lepidoptera	Papilionidae		NF	
13	<i>Danaus plexippus</i>	Lepidoptera	Nymphalidae		NF	
14	<i>Monolepta signata</i>	Coleoptera	Chrysomelidae			CV
15	<i>Coccinella transversalis</i>	Coleoptera	Coccinellidae			CV
16	<i>Coccinella septumpunctata</i>	Coleoptera	Coccinellidae			CV
17	<i>Dysdercus cingulatus</i>	Hemiptera	Pyrrhocoridae			CV
18	<i>Nezara viridula</i>	Hemiptera	Pentatomidae			CV

Note - PF: Pollen foragers, NF: Nectar foragers, CV: Casual visitors

Abundance of different non *Apis* insect pollinators/visitors in coriander crops

The documentation of insect visitors unveiled the presence of 14 species from five orders, encompassing twelve families that were observed visiting the coriander flowers (Table 4). Among the non *Apis* insect pollinators Dipterans were the major floral visitors comprising 3 species from two families viz., *Erisyrphus sp.*, *Eristalis tenax* L., (Syrphidae), *Musca domestica* L. (Muscidae). They were followed by Hymenoptera which comprised 3 species from three families viz., *Xylocopa fenestrata* Fab. (Apidae), *Rhynchium sp.* (Spinola) (Vespidae), *Camponotus compressus* Fab.

(Formicidae). Coleoptera included 3 species from two families viz., *Menochilus sexmaculatus*, *Coccinella septumpunctata* L. (Coccinellidae), *Monolepta signata* (Chrysomelidae). Lepidoptera comprised 4 species from four family viz., *Euploea core* (Nymphalidae), *Amata cyssea* S. (Erebidae) and *Papilio demolius* L. (Papilionidae), *Pieris brassicae* L. (Pieridae). Hemiptera consist of only single species viz., *Dysdercus cingulatus* (Pyrrhocoridae). Among these insect pollinators *Eristalis tenax* L., *Erisyrphus sp.*, *Rhynchium sp.*, and *Xylocopa fenestrata* Fab were the most frequent visitors.

Table 4: List of non *Apis* insect pollinators/visitors of coriander crop

S. No.	Common Name	Scientific Name	Family	Order
1.	Carpenter bee	<i>Xylocopa fenestrata</i> Fab.	Apidae	Hymenoptera
2.	Black ants	<i>Camponotus compressus</i> Fab.	Formicidae	
3.	Vespid wasp	<i>Rhynchium sp.</i> (Spinola)	Vespidae	
4.	Hoverfly	<i>Eristalis tenax</i> L.	Syrphidae	Diptera
5.	Marmalade hoverfly	<i>Erisyrphus sp.</i>		
6.	House fly	<i>Musca domestica</i> L.	Muscidae	Lepidoptera
7.	Lemon butterfly	<i>Papilio demolius</i> L.	Papilionidae	
8.	Cabbage butterfly	<i>Pieris brassicae</i> L.	Pieridae	
9.	Common crow butterfly	<i>Euploea core</i>	Nymphalidae	
10.	Tiger moth	<i>Amata cyssea</i> S.	Erebidae	Coleoptera
11.	Flea beetle	<i>Monolepta signata</i>	Chrysomelidae	
12.	Six spotted zig-zag leady bird beetle	<i>Menochilus sexmaculatus</i>	Coccinellidae	
13.	Leadybird beetle	<i>Coccinella septumpunctata</i> L.		
14.	Red cotton bug	<i>Dysdercus cingulatus</i>	Pyrrhocoridae	Hemiptera

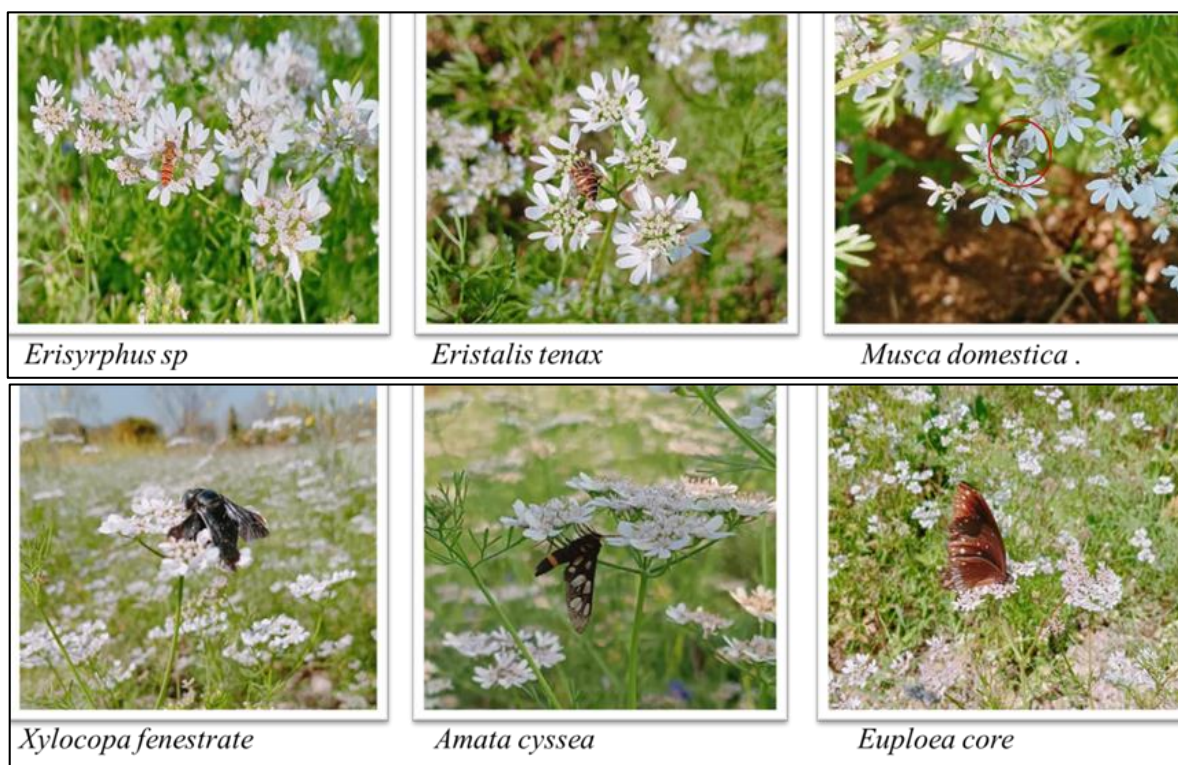


Fig 3: Different species of insect pollinators visiting on coriander flowers

Relative abundance of non *Apis* Insect pollinators/visitors in coriander

In present investigation order Diptera was the most dominant and most frequent visitors constituted 46.85 per cent of the total abundance followed by order Hymenoptera (25.91%), Coleoptera (13.07%), and Lepidoptera (9.68%), while lowest abundance was recorded for order Hemiptera (4.50%).

Among the non *Apis* insect pollinators *Eristalis tenax* L. (20.50%), *Erisyrphus sp.* (19.82%), *Rhynchium sp.* (10.59%), and *Xylocopa fenestrata* Fab. (9.01%) were the most frequent visitors, while *Euploea core* (1.35%) was recorded visiting the coriander flowers less frequently (Table 5).

The present findings were in conformity with Sagar (2002) [7], who reported the potential of different species of insect

pollinators, syrphid flies and other dipterous flies in the pollination of crop revealed that flower of coriander, fennel and oilseed crop were very attractive to honeybees, syrphid flies and some dipterous flies. The present findings were

similar to the findings of Chandraker (2022), who recorded among the total pollinators *Eristalis sp.* (6.35%), *Episyrphus balteatus* (5.32%), *Episyrphus sp.* (4.26%), *Musca sp.* (4.22%) and others species (2.45%).

Table 5: Abundance of non *Apis* Insect pollinators/visitors in coriander

Order	Family	Species	Species abundance (%)	Order abundance (%)
Hymenoptera	Apidae	<i>Xylocopa fenestrata</i> Fab.	9.01	25.91
	Vespidae	<i>Rhynchium sp.</i> (Spinola)	10.59	
	Formicidae	<i>Camponotus compressus</i> Fab.	6.31	
Diptera	Syrphidae	<i>Eristalis tenax</i> L.	20.50	46.85
		<i>Erisyrphus sp.</i>	19.82	
	Muscidae	<i>Musca domestica</i> L.	6.53	
Coleoptera	Chrysomelidae	<i>Monolepta signata</i>	3.38	13.07
	Coccinellidae	<i>Menochilus sexmaculatus</i>	4.28	
		<i>Coccinella septumpunctata</i> L.	5.41	
Lepidoptera	Erebidae	<i>Amata cyssea</i> S.	4.05	9.68
	Pieridae	<i>Pieris brassicae</i> L.	2.03	
	Papilionidae	<i>Papilio demolius</i> L.	2.25	
	Nymphalidae	<i>Euploea core</i>	1.35	
Hemiptera	Pyrrhocoridae	<i>Dysdercus cingulatus</i>	4.50	4.50
Total				100.00

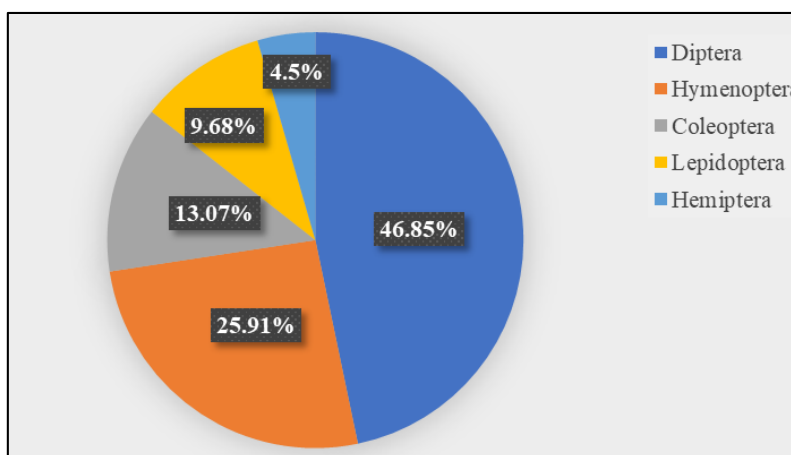


Fig 4: Relative abundance of non *Apis* Insect visitors/pollinators on coriander

In coriander crop among the non *Apis* insect pollinators all the dipterans (three species) and lepidopterans (four species) were found as only nectar forager. Among the three species of hymenopteran visitors of coriander flowers, two species were

found as both pollen foragers and nectar foragers and one species as only nectar foragers. Coleoptera (three species), and Hemiptera (one species) were found as casual visitors of the coriander flowers (Table 6).

Table 6: Foraging preference of non-*Apis* insect pollinators/visitors on Coriander flower

S. No.	Name of the species	Order	Family	Pollen foragers (PF)	Nectar foragers (NF)	Casual visitors (CV)
1	<i>Xylocopa fenestrata</i>	Hymenoptera	Apidae	PF	NF	
2	<i>Rhynchium sp.</i>	Hymenoptera	Vespidae	PF	NF	
3	<i>Camponotus compressus</i>	Hymenoptera	Formicidae		NF	
4	<i>Eristalis tenax</i>	Diptera	Syrphidae		NF	
5	<i>Erisyrphus sp.</i>	Diptera	Syrphidae		NF	
6	<i>Musca domestica</i>	Diptera	Muscidae		NF	
7	<i>Amata cyssea</i>	Lepidoptera	Erebidae		NF	
8	<i>Papilio demolius</i>	Lepidoptera	Papilionidae		NF	
9	<i>Euploea core</i>	Lepidoptera	Nymphalidae		NF	
10	<i>Pieris brassicae</i>	Lepidoptera	Pieridae		NF	
11	<i>Monolepta signata</i>	Coleoptera	Chrysomelidae			CV
12	<i>Menochilus sexmaculatus</i>	Coleoptera	Coccinellidae			CV
13	<i>Coccinella septumpunctata</i>	Coleoptera	Coccinellidae			CV
14	<i>Dysdercus cingulatus</i>	Hemiptera	Pyrrhocoridae			CV

Note - PF: Pollen foragers, NF: Nectar foragers, CV: Casual visitors.

Conclusion

Accordingly, the results of the current investigation showed that order Diptera was the predominant group among all non *Apis* insect pollinators/visitors.

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