



Diversity and Abundance of Insect Pollinator Fauna in Coriander (*Coriandrum sativum* L.) and Ajwain (*Trachyspermum ammi* L.) in North Karnataka

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Abstract: Coriander (*Coriandrum sativum* L.) and ajwain (*Trachyspermum ammi* L.) are the two important seed spices being domesticated and marketed in India. Understanding the abundance and diversity of insect fauna which are actively involved in cross pollination of them is crucial in production of higher quality seed yield. During the study period, coriander flowers were visited by 17 species of pollinators (5 Hymenopterans, 6 Dipterans, 2 Coleopterans and 4 Lepidopterans) and 23 species of pollinators (6 Hymenopterans, 10 Dipterans, 2 Coleopterans and 5 Lepidopteran) were documented on ajwain flowers from the districts surveyed (Gadag, Haveri and Dharwad districts for coriander; Vijayapura, Bagalkot and Dharwad districts for ajwain). Diversity (Simpson index of diversity, Shannon-Wiener index, Evenness and Similarity index) of pollinators in coriander was higher in Gadag followed by Haveri and Dharwad districts. In ajwain, the diversity (Simpson index of diversity, Shannon-Wiener index, Evenness and Similarity index) of pollinators was higher in Vijayapura followed by Bagalkot and Dharwad districts. Meanwhile, in both coriander and ajwain, *Apis florea* was the most predominant pollinator followed by *A. cerana indica* which need to be conserved through potential conservative agronomical practices to enhance the seed yield.

Keywords: Abundance, Ajwain, Coriander, Diversity, Insect pollinators

Since ancient times, Indian spices and spicy cuisine have been popular all across the world. Traders from all over the globe have come to our subcontinent in search of spices. Out of 109 spices found in the world, 75 are grown in India, which includes fourteen seed spices (cumin, coriander, fennel, fenugreek, ajwain, anise, dill, nigella, pepper, cardamom, clove, cinnamon, nutmeg and bay leaf) commercially grown across the country. India is one of the biggest producer, consumer and exporter of seed spices because of its diverse soil and climatic regions, ideal to grow many of the seed spices. These crops are mostly grown in the country's semi-arid and arid zones, which have dry or rainy chilly weather conditions. Together, the states of Rajasthan, Gujarat, and parts of Madhya Pradesh are known as the "bowl of seed spices," accounting for more than 80 per cent of the country's yearly production. Coriander (*Coriandrum sativum* L.) also known as cilantro or Chinese parsley, belongs to the family Apiaceae (2n=22). It is a smooth, erect annual medium height herb, grown for its seeds and tender green feathery leaves. Green leaves are used in the preparation of chutney and also used as seasonings in curries, soups and sauces. All plant parts are used due to the presence of essential oils and pleasant aromatic character. Coriander produces a large amount of nectar, which attracts a variety of insects for

pollination; an external effect that is both ecological and economic in value; as a result, it is also a good melliferous plant, producing 500 kg of honey from a single hectare of coriander. Ajwain (*Trachyspermum ammi* L.), commonly known as carom seed or bishop's weed, is a member of the Apiaceae family and a major seed spice crop in India. It is an annual herbaceous shrub with little greyish brown egg-shaped fruits. Because of the inclusion of an essential oil, it has a distinct odor and flavor (2-4%). Thymol is mostly found in ajwain oil. Its distinctive fragrant scent and strong flavor make it popular as a spice in curries. It can be used alone or in combination with other spices and condiments. Ajwain's most significant usage is medical, and it is a common home cure for indigestion. Its seed and oil are highly sought after for its antispasmodic, stimulant, tonic, and fragrant carminative effects (Rathore et al 2014). The pollination constraints have raised serious threats to crop production and plant diversity. Approaches for integrated pollination services using well-managed pollinators for crop species and to make the habitats favourable for the survival of insect pollinators is much needed (Shivanna et al 2020). Over the major pollinators, coriander and ajwain crops are cross-fertilized by insects to the extent of 60-70 per cent and play a vital role in increasing crop productivity. Hence, the present investigation

was undertaken to document the abundance and diversity of insect pollinators through random survey in major cropping area of northern Karnataka.

MATERIAL AND METHODS

Survey: Roving survey was carried out during *rabi* 2020-21 in coriander and ajwain growing districts of Karnataka covering Gadag (15.4315° N, 75.6355° E) and Gajendragad (15.7361° N, 75.9710° E) talukas of Gadag district, Haveri (14.7951° N, 75.3991° E) and Ranebennur (14.6154° N, 75.6288° E) talukas of Haveri district to record pollinators diversity in coriander ecosystem. Similarly, Basavana bagevadi (16.5681° N, 75.9754° E) and Muddebihal (16.3396° N, 76.1291° E) talukas of Vijayapura district, Hungunda (16.0576° N, 76.0609° E) and Guledgudda (16.0496° N, 75.7895° E) talukas of Bagalkot district were surveyed to record pollinators diversity in ajwain ecosystem. From each taluka, two villages were selected and in each village one field was surveyed. In Main Agricultural Research Station (MARS) Dharwad, the experimental plots of coriander (Variety: DWD-3) and ajwain (Variety: Ajmer ajwain-1) were raised as per the package of practices except plant protection measures under the black soil condition.

Observations: Randomly 20 net sweeps were taken by transect walk under open pollination conditions during peak flowering period on clear sunny days (Devi et al 2015). During the period of survey, pollinators visiting the crops were collected, preserved and identified with the help of available taxonomic keys and by experts to know the diversity of pollinators. Village wise collected data were pooled and the relative abundance of pollinators was expressed in percentage taluka wise.

Diversity indices of pollinators

a. Shannon-Wiener diversity index (H): The Shannon-Wiener diversity index is calculated by using the following equation: $H = -\sum p_i \ln p_i$

Where, p_i is the proportion of the i^{th} species of pollinator and \ln is the natural log with base $e=2.718$.

b. Simpson index of diversity (1-D): It was calculated by $D = 1 - \sum p_i^2$

c. Evenness (J): Relative abundance of each species in a particular habitat was calculated using the following formula: $J = H' / \ln S$

Where, H' is the Shannon-Wiener diversity index or Simpson index of diversity and 'S' is the total number of species present.

d. Sorenson's similarity index:

$$S = \frac{2C}{A+B}$$

Where, A= number of species in sample A, B= number of

species in sample B and C= number of species common to both samples

e. Relative abundance of insect pollinators: It was calculated by using formula to know the dominance of species in coriander and ajwain ecosystem.

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

RESULTS AND DISCUSSION

Pollinator fauna of coriander: Most of the insect pollinators encountered during the present study have been reported earlier. However, the occurrence of *Nyctemera coleta* (Stoll), *Prostos dubiosa* (Semper) and *Eristalinus obliquus* Wiedemann as pollinators of coriander is the first record from Karnataka. Gadag district (Gajendragad and Gadag talukas), recorded 13 species of pollinators from 6 families under 4 orders (Table 1). Among the 4 orders of insect pollinators recorded, Hymenopterans were the most dominant which constituted 58.85 per cent followed by Dipterans (27.78 %), Coleopterans (9.35 %) and Lepidopterans (3.61 %). Among the order Hymenoptera, Apidae accounted for 4 species of honey bees and a lone species belonged to Halictidae. Order Diptera was represented by 4 species belonging to a Syrphidae family. Similarly, the order Coleoptera was represented by two species belonging to Coccinellidae while, Lepidoptera was represented 2 species belonging to the family Lycaenidae. Haveri district (Haveri and Ranebennur talukas), accounted for 12 species belonging to 4 families under 4 orders (Table 1). Among the 4 orders of insect pollinators recorded, Hymenopterans were the most predominant which constituted 60.14 per cent followed by Dipterans, Coleopterans and Lepidopterans. Among the order Hymenoptera, Apidae accounted for 4 species of honey bees. Order Diptera was represented by 4 species belonging to a Syrphidae family and Coleoptera was represented by two species belonging to Coccinellidae. Lepidoptera was represented by 2 species belonging to the family Lycaenidae. During fixed plot survey conducted in Dharwad, 13 species belonging to 6 families under 4 orders were recorded (Table 1). Among the 4 orders of insect pollinators recorded, Hymenopterans were the most prominent pollinators (73.47 %) followed by Dipterans, Coleopterans and Lepidopterans. Among the order Hymenoptera, Apidae accounted for 4 species of honey bees and a lone species belonged to Halictidae. Order Diptera was represented by 5 species of which 4 species belonged to Syrphidae and a lone species from Muscidae. Similarly, order Coleoptera was represented by two species belonging to Coccinellidae while, Lepidoptera was represented by a lone species belonged to Lycaenidae.

Between the location there is no variation in diversity of pollinators at taxonomic levels in coriander ecosystem.

The present results are partially in agreement with the findings of Prasanna (2003) who reported 14 species of pollinators belonging to 9 families (Apidae, Halictidae, Syrphidae, Asilidae, Pieridae, Pyraustidae, Danaidae, Coccinellidae and Crysomelidae) included in 4 different orders. Further *A. florea* was the most prominent pollinator

(45.52 %) followed by *A. cerana indica* and *A. dorsata* in Dharwad. However, during the present study reports of the family Asilidae, Pieridae, Pyraustidae, Crysomelidae and Danaidae were not recorded. Sharma and Meena (2019) reported 28 insect species belonging to 18 families of 6 orders were visited coriander flowers. Among the pollinators, *A. florea* was the most dominating species, followed by *A. mellifera* and *E. balteatus*. Shivashankara *et al.* (2016)

Table 1. Diversity of pollinator fauna of coriander

Common name	Scientific name	Family	Species abundance (%)						
			Gadag district (December, 2020)			Haveri district (December, 2020)		Dharwad (December 2020 to January 2021)	
			Gajendragad	Gadag	Mean	Haveri	Ranebennur		Mean
Hymenoptera									
Little bee	<i>Apis florea</i> Fabricius	Apidae	30.18	28.27	29.22	25.27	22.72	23.99	31.63
Indian bee	<i>A. cerana indica</i> Fabricius		12.5	15.20	13.85	20.44	30.00	25.22	26.17
Rock bee	<i>A. dorsata</i> Fabricius		6.77	10.90	8.83	9.29	7.72	8.50	5.86
Stingless bee	<i>Trigona iridipennis</i> Smith		4.33	3.63	3.98	2.60	2.27	2.43	5.53
Halictid bee	<i>Lasioglossum</i> sp.	Halictidae	3.49	2.45	2.97	-	-	-	4.28
Relative abundance (Order)			58.85 %			60.14 %		73.47 %	
Diptera									
Common hover fly	<i>Ischiodon scutellaris</i> Fabricius	Syrphidae	11.23	11.20	11.21	5.94	5.18	5.56	4.07
Long hover fly	<i>Sphaerophoria indiana</i> Bigot		8.66	8.18	8.42	6.69	3.63	5.16	4.05
Syrphid	<i>Sphaerophoria macrogaster</i> Thomson		6.13	6.81	6.47	8.55	5.20	6.87	4.26
Marmalade hoverfly	<i>Episyrphus balteatus</i> De Geer		2.16	1.21	1.68	-	-	-	3.80
Syrphid	<i>Episyrphus obliquus</i>		-	-	-	0.37	-	0.18	-
Musca sp.	<i>Musca</i> sp.	Muscidae	-	-	-	-	-	-	1.76
Relative abundance (Order)			27.78 %			17.77 %		17.94 %	
Coleoptera									
Transverse ladybird	<i>Coccinella transversalis</i> Fabricius	Coccinellidae	7.22	5.45	6.33	8.92	10.1	9.51	4.07
Indian wave stiped ladybug	<i>Cheilomenes sexmaculata</i> Fabricius		3.24	2.81	3.02	5.94	7.72	6.83	3.59
Relative abundance (Order)			9.35 %			16.34 %		7.66 %	
Lepidoptera									
Tailless lineblue	<i>Prosotas dubiosa</i> (Semper)	Lycaenidae	2.88	3.63	3.25	1.85	1.81	1.83	-
Pea blue	<i>Lampides boeticus</i>		-	-	-	4.08	3.63	3.85	-
Plain cupid	<i>Luthrodes pandava</i> (Horsfield)		-	-	-	-	-	-	0.88
Marbled moth	<i>Nyctemera coleta</i> (Stoll)	Erebidae	0.72	-	0.36	-	-	-	-
Relative abundance (Order)			3.61 %			5.68 %		0.88 %	

reported that coriander flowers were visited by insect species belonging to Hymenoptera, Diptera, Lepidoptera and Coleoptera. Among these, *A. cerana indica*, *A. mellifera*, *A. florea*, *E. balteatus*, *E. tenax*, *Syrphus* spp. and *Musca* sp. were the dominant pollinators in Pantnagar (Uttarakhand). Thus, various studies have highlighted the dominance of

Table 2. Diversity of pollinator fauna of ajwain

Common name	Scientific name	Family	Species abundance (%)						
			Vijayapura (January, 2021)			Bagalkot (January, 2021)			Dharwad (January to February, 2021)
			Basavan bagevadi	Muddeb hihal	Mean	Hungunda	Guledagudda	Mean	
Hymenoptera									
Little bee	<i>Apis florea</i> Fabricius	Apidae	18.51	22.54	20.52	26.66	23.78	25.22	27.67
Indian bee	<i>A. cerana indica</i> Fabricius		12.50	15.16	13.83	15.71	14.07	14.89	20.68
Rock bee	<i>A. dorsata</i> Fabricius		4.62	9.42	7.02	7.61	5.33	6.47	3.82
Stingless bee	<i>Trigona iridipennis</i> Smith		5.09	5.32	5.20	6.19	4.90	5.54	3.94
Halictid bee	<i>Lasioglossum</i> sp.	Halictidae	-	-	-	2.38	1.40	1.89	2.96
Scoliid wasp	<i>Scolia affinis</i> Guerin	Scoliidae	-	-	-	-	-	-	0.15
Relative abundance (Order)			46.57 %			54.07 %			59.22 %
Diptera									
Common hover fly	<i>Ischiodon scutellaris</i> Fabricius	Syrphidae	7.94	4.91	6.42	3.33	7.76	5.54	4.45
Long hover fly	<i>Sphaerophoria indiana</i> Bigot		5.82	4.09	4.95	-	-	-	4.02
Syrphid	<i>Sphaerophoria macrogaster</i> Thomson		6.94	6.55	6.74	7.14	5.82	6.48	3.83
Marmalade hoverfly	<i>Episyrphus balteatus</i> De Geer		5.59	3.70	4.64	-	-	-	4.27
Syrphid	<i>Phytomyia errans</i> Fabricius		9.25	6.96	8.10	8.57	9.70	9.13	5.14
Syrphid	<i>Eristalinus arvorum</i> Fabricius		-	-	-	-	-	-	5.01
Syrphid	<i>Serratoparagus serratus</i> Fabricius		-	-	-	-	-	-	4.25
House fly	<i>Musca domestica</i>	Muscidae	3.20	3.25	3.23	-	-	-	0.84
Winged fly	<i>Physiphora anea</i> Fabricius	Ulidiidae	-	-	-	-	-	-	0.94
Relative abundance (Order)			34.08 %			21.14 %			32.75 %
Coleoptera									
Transverse ladybird	<i>Coccinella transversalis</i> Fabricius	Coccinellidae	11.10	8.19	9.65	9.04	10.67	9.85	3.73
Indian wave stiped ladybug	<i>Cheilomenes sexmaculata</i> Fabricius		6.01	6.55	6.29	7.60	8.25	7.93	3.25
Relative abundance (Order)			15.94 %			17.83 %			6.98 %
Lepidoptera									
Tailless lineblue	<i>Prosotas dubiosa</i> (Semper)	Lycaenidae	-	-	-	-	-	-	0.25
Pea blue	<i>Lampides boeticus</i>		3.24	3.27	3.26	3.33	3.88	3.60	0.56
Plain cupid	<i>Luthrodes pandava</i> (Horsfield)		-	-	-	1.42	2.91	2.16	-
Common shot silverline	<i>Cigaritis ictis</i> (Hewitson)		-	-	-	0.95	1.45	1.20	0.20
Karwar swift skipper	<i>Caltoris canaraica</i> (Moore)	Hesperiidae	-	-	-	-	-	-	0.12
Relative abundance (Order)			3.26 %			6.96 %			1.13 %

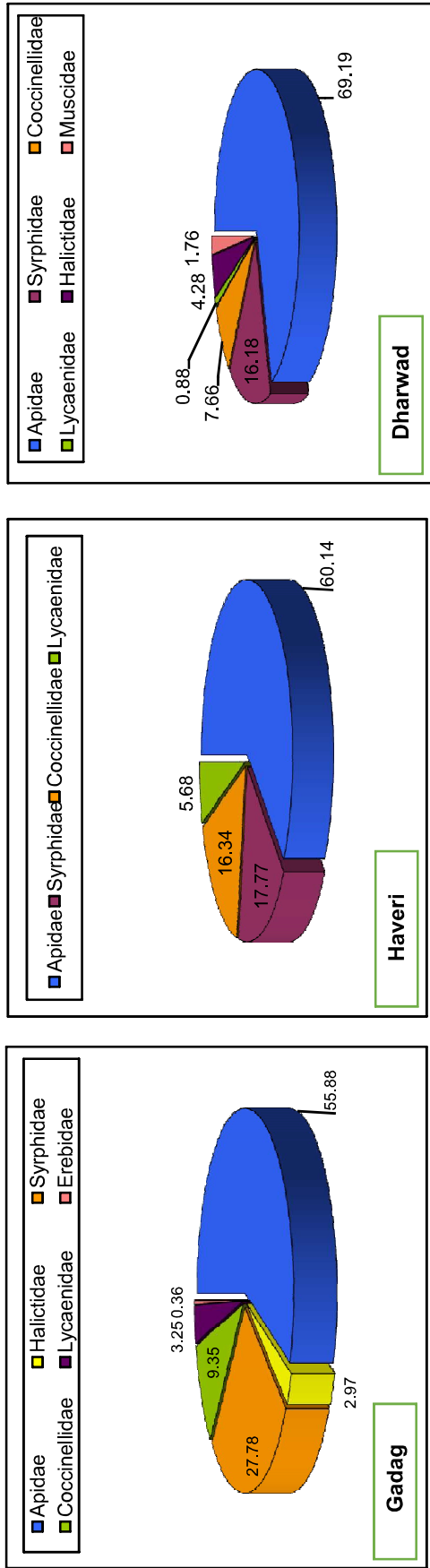


Fig. 1. Relative abundance (%) of insect pollinators in coriander from different surveyed districts (Family)

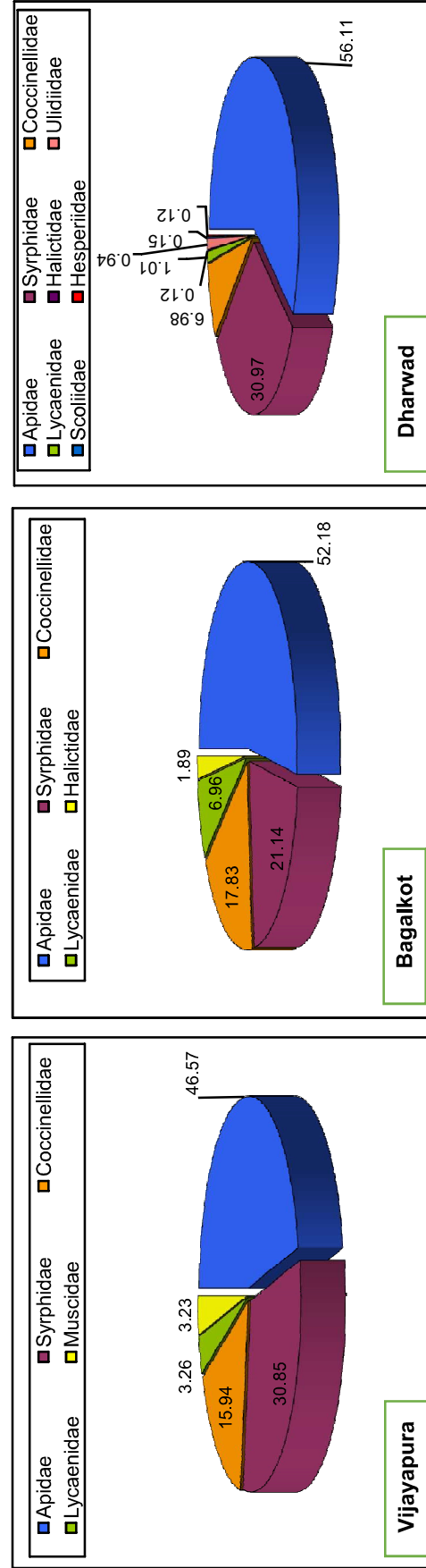


Fig. 2. Relative abundance (%) of insect pollinators in ajwain from different surveyed districts (Family)

Table 3. Diversity indices of pollinators in coriander

Diversity indices	Coriander			Ajwain		
	Gadag	Haveri	Dharwad	Bagalkot	Vijayapura	Dharwad
Simpson index of diversity (1-D)	0.87	0.85	0.83	0.85	0.89	0.83
Shannon-Wiener index (H)	2.21	2.16	2.09	2.29	2.41	2.27
Evenness (J)	0.76	0.67	0.62	0.74	0.87	0.48
Similarity index (%)	96	95	82	100	100	68

honey bees as the most important pollinators not only in coriander also in other crops.

Pollinator fauna of ajwain: The majority of the pollinators observed during this investigation have previously been documented. However, the occurrence of *Phytomyia errans* Fabricius, *Eristalinus arvorum* Fabricius *Physiphora anea* Fabricius, *Sphaerophoria macrogaster* Thomson, *Serratoparagus serratus* Fabricius, *Lampides boeticus* Linnaeus, *Cigaritis ictis* (Hewitson) and *Scolia affinis* Guerin as pollinators of ajwain is the first record from Karnataka. Vijayapura district (Basavan bagevadi and Muddebihal talukas), recorded 13 species of pollinators belonging to 5 families under 4 orders (Table 2). Among the 4 orders of insect pollinators recorded, Hymenopterans were the most prominent pollinators (46.57 %) followed by Dipterans and Coleopterans. Among the order Hymenoptera, Apidae accounted for 4 species of honey bees. Order Diptera was represented by 6 species of which 5 species belonged to Syrphidae and a lone species from Muscidae. Similarly, the order Coleoptera was represented by two species belonging to Coccinellidae while, Lepidoptera was represented by a lone species belonging to the family Lycaenidae. Bagalkot district (Hungunda and Guledagudda talukas), recorded 13 species of pollinators belonging to 5 families under 4 orders (Table 2). Among the 4 orders of insect pollinators recorded, Hymenopterans were the most prominent pollinators (54.07 %) followed by Dipterans, Coleopterans and Lepidopterans. Among the order Hymenoptera, Apidae accounted for 4 species of honey bees and a lone species belonged to Halictidae. Order Diptera was represented by 3 species belonging to a Syrphidae family. Similarly, the order Coleoptera was represented by two species belonging to Coccinellidae while, Lepidoptera was represented by 3 species belonging to the family Lycaenidae. 21 species belonging to 9 families under 4 orders were documented during fixed plot survey, conducted in Dharwad (Table 2). Among the 4 orders of insect pollinators recorded, Hymenopterans were the most predominant (59.22 %) followed by Dipterans and Coleopterans. Among the order Hymenoptera, Apidae accounted for 4 species of honey bees and a lone species from Halictidae and Scoliidae. Order Diptera was represented by 9 species of which 7 species

belonged to Syrphidae and one each from Muscidae and Ulidiidae families. Similarly, order Coleoptera was represented by two species belonging to Coccinellidae while, the order Lepidoptera was represented by 4 species of which 3 species belonged Lycaenidae and a lone species to belonged to the family Hesperidae. Among the districts surveyed in ajwain crop ecosystems, the diversity of pollinators was more in Dharwad compared to Vijayapura and Bagalkot districts. Several authors have reported honey bees as dominant pollinators in related coriander crop (Khalid et al 2008, Kant et al 2013, Roopashree 2011, Ranjitha et al 2019). Ajwain being a member of same family as that of coriander, it is possible that the diversity and abundance of pollinators is similar to coriander.

In both coriander and ajwain crops, 70 per cent of pollinators are similar from the above obtained results. Among the pollinators recorded, *A. florea* is the most prominent pollinator followed by *A. cerana indica* and Syrphids. Coriander and ajwain flowers are rich in pollen and nectar content which attracted the pollinators. Coccinellid species might act as fortuitous pollinators while moving from one plant to another plant in search of their prey. Similarly, in the process of visiting flowers, nectar feeding lepidopterans also frequently act as pollinators.

Diversity indices of pollinators in coriander and ajwain:

In both coriander and ajwain crops, the Simpson index of diversity and Shannon-Wiener index did not vary much among the districts surveyed (Gadag, Haveri and Dharwad districts for coriander, Vijayapura, Bagalkot and Dharwad districts for ajwain) (Table 3). The Evenness of species differed much between the districts. However, similarity was noticed in Gadag and Haveri, Vijayapura and Bagalkot than Dharwad district in coriander and ajwain ecosystem respectively. Diversity and species richness of pollinators varies from region to region. The density of insects on blossom depends on several factors like flower color, availability of floral rewards, shape, size, variety, crop protection measures and weather conditions. Since, it was the first kind of attempt, supported literatures on diversity indices of pollinators are not available to make any meaningful comparison.

CONCLUSIONS

The ajwain flowers are visited by a greater number of pollinators than the coriander due to floral scents, floral rewards and duration of flowering. Meanwhile, in both coriander and ajwain, *A. florea* was the most predominant pollinator followed by *A. cerana indica* which need to be conserved through potential conservative agronomical practices to enhance the seed yield. The information on the type of pollinators and peak activities is expected to conserve the pollinators naturally or may be pollinators rearing through artificially and to schedule crop protection measures.

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