



Studies on diversity, distribution and relative abundance of insect pollinators on *Litchi* in Kyarda Doon Valley of district Sirmaur, Himachal Pradesh

Anjana Chauhan*, MS Thakur

Department of Biosciences, Himachal Pradesh University, Shimla, Himachal Pradesh, India

Abstract

Diversity, distribution and relative abundance studies were conducted on insect pollinators of *Litchi* in Kyarda Doon valley of district Sirmaur, Himachal Pradesh during the flowering period i.e. April-May 2019. Collections were made regularly from 5 different localities viz. Dhaulakuan, Majra, Paonta Sahib, Rajban and Sataun. Insect diversity studies showed 16 species of insect pollinators belonging to 4 orders and 9 families. Of these, 6 species belonged to order Hymenoptera, 5 to Diptera, 4 to Coleoptera and 1 to Hemiptera. Relative abundance analysis of different insect pollinators were also studied which revealed that hymenopterans were the most prominent insect visitors of litchi flowers in all the localities i.e. Dhaulakuan (66.78%), Paonta Sahib (54.45%), Majra (61.45%), Rajban (64.27%) and Sataun (64.05%). It was also observed that *Apis mellifera* was the most abundant insect visitor to litchi flowers in all the localities. Besides hymenopterans, dipterans also constituted an important group of insect pollinators followed by coleopterans and hemipterans.

Keywords: insect pollinators, *litchi*, diversity, distribution, relative abundance, Kyarda doon valley

Introduction

Pollination is an important step in the reproduction of seed plants. The transfer of pollen grains from male anther to the female stigma of flowering plants depend on animal pollination through insects, birds, bats and others, while insects playing the major role (Abrol, 2012) ^[1]. Cross pollination by insects is of great importance in increasing crop yield, improving fruit and seed quality. Insect pollinators mainly belong to orders Coleoptera, Lepidoptera, Diptera, Thysanoptera and Hymenoptera. These pollinators also provide an important ecosystem service which is essential for sustaining wild floral biodiversity. The annual economic value of insect pollinators to agricultural productivity for the major crops cultivated in the state of Himachal Pradesh is USD 365 million. For litchi the annual economic value of insect pollination is USD 2.25 million in Himachal Pradesh (Klein *et al.*, 2007) ^[8].

Litchi (*Litchi chinensis*) is an important sub-tropical evergreen fruit crop belonging to family Sapindaceae. It is a cross pollinated plant. Insects are the basic agents for the transfer of pollen and generally considered best to obtain a good and profitable production (Badiyala and Garg, 1990; DuToit, 1994; Menzel and Waite, 2005) ^[3]. Litchi flowers are visited by variety of insects including Coleoptera, Hemiptera, Homoptera and Lepidoptera; however, honey bees, flies, ants and wasps are important floral visitors (Chaturvedi, 1965) ^[4]. In India, the bulk of litchi growing area lies in Bihar; other areas are sub mountain tracts of Uttar Pradesh, West Bengal, Punjab, Tripura, Assam and Odisha. Soil and micro climatic conditions of Jharkhand, Uttarakhand and Himachal Pradesh also favour this fruit crop to grow and flourish. Varieties of litchi grown in India have also been subsequently described (Singh *et al.*, 1998) ^[10]. The most common varieties include *Shahi*, *Kasaba*, *Bedana*, *China*, *Ajhauli*, *Bombai*, *Purbi*, *Dehradun*, *Rose Scented*, *Muzaffarpur* and *Swarna Roopa* etc. Low hill and valley areas near the plains of Himachal Pradesh are found

to be suitable for litchi cultivation. Areas under lower Shiwalik hills region are the major litchi producers which include some areas of district Kangra, Una, Hamirpur, Solan and Sirmaur.

Materials and Methods

Studies on diversity, distribution and relative abundance of litchi pollinators were made by collecting the flower visitors from different sites viz. Dhaulakuan, Majra, Paonta Sahib, Rajban and Sataun located in Kyarda doon valley of district Sirmaur, Himachal Pradesh. Different insect pollinators were collected during the flowering season i.e. April-May 2019. They were killed, stretched and preserved for identification. Taxonomically significant morphological features, genitalia and wing venation were studied. Studies on relative abundance of various insect visitors were made by selecting plant at random on the basis of their size, age, flowering stage and number of branches.

Relative abundance of different insect visitors was determined in terms of their visit per 500 flowers/10 minutes (Verma and Chauhan, 1985) ^[13]. The observation was recorded at regular intervals during 0900-1700 hours of a day and average count at these hours gave abundance of insect pollinators for that particular day (Southwood, 1978) ^[11]. Pollen grains were identified by comparing them with pollen removed from flowers harvested from the crop. In order to assess the species diversity and relative abundance, some statistical tests were used to analyze several measures of abundance and diversity from the collected data. Firstly, the mean and standard error was calculated for each species from the observations recorded at regular intervals of time. Similarly family number, family percentage, order number and order percentage were calculated for all the sites of insect collection and the results were tabulated.

Results and Discussion

Diversity and distribution studies revealed that litchi flowers

were visited by 16 species of insect pollinators in five different localities i.e. Dhaulakuan, Paonta Sahib, Majra, Rajban and Sataun of Kyarda Doon valley of district Sirmaur, Himachal Pradesh. Out of these 16 species, 6 belonged to order Hymenoptera, 5 to Diptera, 4 to Coleoptera, and 1 to Hemiptera. Insect species belonging to Hymenoptera are, *Ropalidia brevita* (Das & Gupta), *Camponotus* sp., *Apis dorsata* (Fabricius), *Apis mellifera* (Linnaeus), *Apis cerana* (Fabricius) and *Trigona laeviceps* (Smith); to Diptera are, *Eristalis (Eoseristalis) cerealis* (Fabricius), *Eristalis (Eristalis) tenax* (Linnaeus), *Episyrphus balteatus* (De Geer), *Sphaerophoria (Sphaerophoria) indiana* (Bigot) and *Musca domestica* (Linnaeus); to Coleoptera are, *Chauliognathus pennsylvanicus* (De Geer), *Coccinella septumpunctata* (Linnaeus), *Exochomus* sp. and *Altica cyanea* (Weber) and to Hemiptera, *Chrysocoris purpureus* (Westwood) (Table 1).

Different investigations have reported different pollinators on various tropical and sub-tropical fruit crops. For example, Halder *et al.* (2019) [6] studied the role of insect pollinators in some of the tropical fruit crops. Srivastava *et al.* (2017) [12] reported 20 pollinator species under 23 genera of 8 families belonging to orders Diptera, Hymenoptera and Coleoptera visiting litchi flowers in Muzaffarpur, Bihar. Jamwal *et al.* (2019) [7] found that litchi flowers were visited by 46 species of insect belonging to five orders viz. Hymenoptera, Diptera, Lepidoptera, Coleoptera and Hemiptera in the orchards located in Sunni area of Shimla hills, Himachal Pradesh.

While studying the relative abundance of insect pollinators on litchi crops, hymenopterans were found the most prominent insect visitors of litchi flowers in all the localities i.e. Dhaulakuan (66.78%), Paonta Sahib (54.45%), Majra (61.45%), Rajban (64.27%) and Sataun (64.05%). Studies on relative abundance of insect pollinators on litchi revealed 6 species of Hymenoptera of which 4 belonged to family Apidae and 1 each to Vespidae and Formicidae. Insects belonging to family Apidae were the most common in all the localities i.e. Dhaulakuan (63.82%), Paonta Sahib (48.39%), Majra (51.89%), Rajban (58.79%) and Sataun (59.46%) followed by family Formicidae and Vespidae. *Apis mellifera* was the most abundant insect visitor in all the 5 localities i.e. Dhaulakuan (30.16±1.11, 25.57%), Paonta Sahib (14.83± 1.06, 19.31%), Majra (9.50±0.5, 15.17%), Rajban (13.5±0.76, 17.77%) and Sataun (8.33± 0.70, 16.51%). *Ropalidia brevita* of family Vespidae was the least

abundant insect pollinator from this order. Among Diptera, 5 species were recorded of which 4 species belonged to family Syrphidae and 1 to Muscidae. Insects belonging to family Syrphidae were the most common in all the localities i.e. Dhaulakuan (13.12%), Paonta Sahib (23.65%), Majra (15.14%), Rajban (11.03%) and Sataun (10.87%) followed by family Muscidae i.e. Dhaulakuan (2.11%), Paonta Sahib (7.37%), Majra (6.11%), Rajban (4.82%) and Sataun (4.92%). *Episyrphus balteatus* was the most abundant insect visitor to Litchi flowers in all the 5 localities i.e. Dhaulakuan (9.16±0.5, 7.77%), Paonta Sahib (12.50± 0.5, 16.28%), Majra (3.16±0.67, 5.04%), Rajban (4.83±0.67, 6.35%), Sataun (2.16± 0.67, 4.28%). Of order Coleoptera, 4 species were reported of which 3 belonged to family Coccinellidae and 1 each to Cantharidae and Chrysomelidae. Insects belonging to family Coccinellidae were the most common in all the localities i.e. Dhaulakuan (12.81%), Paonta Sahib (8.88%), Majra (9.57%), Rajban (13.37%) and Sataun (14.51%) followed by family Cantharidae and Chrysomelidae. *Coccinella septumpunctata* was the most abundant insect visitor to litchi flowers in all the 5 localities i.e. Dhaulakuan (13.16±1.34, 11.15%), Paonta Sahib (5.16±0.67, 6.72%), Majra (3.83±0.67, 6.11%), Rajban (9.16±0.5, 12.05%) and Sataun (6.66±1.1, 13.20%). *Altica cyanea* was the least abundant insect pollinator from this order. While studying the relative abundance it has been observed that Hemiptera contributed least in all the localities of District Sirmaur i. e. Dhaulakuan (1.55%), Paonta Sahib (2.38%), Majra (3.45%), Rajban (1.97%) and Sataun (2.30%). Studies on relative abundance of insect pollinators of litchi revealed only one species of Hemiptera which belonged to family Scutelleridae (Table 2).

Similar observations were made by different workers. According to Dhaliwal *et al.* (1977) [5], *A. florea* Fab. (50%) and *A. cerana indica* Fab. (26%) were the most abundant hymenopterans visiting litchi crop in the valley areas of the Indian Himalayas. Adlakha *et al.* (1979) [2] found *A. florea* as the most frequent visitor followed by *A. cerana* on *Litchi chinensis* in Himachal Pradesh. Kumar *et al.* (1996) [9] studied the floral biology and pollination by *A. mellifera* in a litchi orchard cultivar 'Calcuttia' at Dehradun, India and observed that Apoidea constituted 89.3% of insect visitors to flowers; *A. mellifera* was the most abundant (44.8% of total), followed by *A. dorsata* (20.7%) and *Trigona iridipennis* (18.9%).

Table 1: Insect species visiting Litchi flowers with their taxonomic status in Kyarda Doon valley of District Sirmaur, Himachal Pradesh

Order	Family	Fauna
Hemiptera	Scutelleridae	1. <i>Chrysocoris purpureus</i> (Westwood)
Coleoptera	Cantharidae	2. <i>Chauliognathus pennsylvanicus</i> (De Geer)
	Coccinellidae	3. <i>Coccinella septumpunctata</i> (Linnaeus)
	Chrysomelidae	4. <i>Exochomus</i> sp.
		5. <i>Altica cyanea</i> (Weber)
Hymenoptera	Vespidae	6. <i>Ropalidia brevita</i> (Das & Gupta)
	Formicidae	7. <i>Camponotus</i> sp.
	Apidae	8. <i>Apis dorsata</i> (Fabricius)
		9. <i>Apis mellifera</i> (Linnaeus)
		10. <i>Apis cerana</i> (Fabricius)
11. <i>Trigona laeviceps</i> (Smith)		
Diptera	Syrphidae	12. <i>Eristalis (Eoseristalis) cerealis</i> (Fabricius)
		13. <i>Eristalis (Eristalis) tenax</i> (Linnaeus)
		14. <i>Episyrphus balteatus</i> (De Geer)

	15. <i>Sphaerophoria (Sphaerophoria) indiana</i> (Bigot)
Muscidae	16. <i>Musca domestica</i> (Linnaeus)

Table 2: Relative abundance of different insect pollinators visiting Litchi flowers (Number of insects/panicle/10 minutes).

Order/family	Genus/Species	X±SE	Percent population	Family Number	Family percentage	Order number	Order percentage
Locality-Dhaulakuan							
Hemiptera							
Scutelleridae	<i>Chrysocoris purpureus</i> (Westwood)	1.83± 0.67	1.55	1.83	1.55	1.83	1.55
Coleoptera							
Cantharidae	<i>Chauliognathus pennsylvanicus</i> (De Geer)	2.5± 0.5	2.11	2.5	2.11		
Coccinellidae	<i>Coccinella septumpunctata</i> (Linnaeus)	13.16± 1.34	11.15				
	<i>Exochomus</i> sp.	2.0± 0.5	1.69	15.16	12.81		
Chrysomelidae	<i>Altica cyanea</i> (Weber)	1.66± 1.1	1.41	1.66	1.41	19.32	16.33
Hymenoptera							
Vespidae	<i>Ropalidia brevita</i> (Das & Gupta)	2.0± 0.57	1.69	2.0	1.69		
Formicidae	<i>Camponotus</i> sp.	1.5± 0.5	1.27	1.5	1.27		
Apidae	<i>Apis dorsata</i> (Fabricius)	12.66± 0.74	10.73				
	<i>Apis mellifera</i> (Linnaeus)	30.16 ±1.11	25.57				
	<i>Apis cerana</i> (Fabricius)	19.16± 0.45	16.24				
	<i>Trigona laeviceps</i> (Smith)	13.33± 0.74	11.30	75.28	63.82	78.78	66.78
Diptera							
Syrphidae	<i>Eristalis (Eoseristalis) cerealis</i> (Fabricius)	2.66± 0.45	2.25				
	<i>Eristalis (Eristalis) tenax</i> (Linnaeus)	1.83± 0.67	1.55				
	<i>Episyrphus balteatus</i> (De Geer)	9.16± 0.5	7.77				
	<i>Sphaerophoria (Sphaerophoria) indiana</i> (Bigot)	1.83± 0.67	1.55	15.48	13.12		
Muscidae	<i>Musca domestica</i> (Linnaeus)	2.5± 0.5	2.11	2.50	2.11	17.98	15.24
Locality-Paonta Sahib							
Hemiptera							
Scutelleridae	<i>Chrysocoris purpureus</i> (Westwood)	1.83± 1.06	2.38	1.83	2.38	1.83	2.38
Coleoptera							
Cantharidae	<i>Chauliognathus pennsylvanicus</i> (De Geer)	1.66± 0.45	2.16	1.66	2.16		
Coccinellidae	<i>Coccinella septumpunctata</i> (Linnaeus)	5.16± 0.67	6.72				
	<i>Exochomus</i> sp.	1.66± 0.74	2.16	6.82	8.88		
Chrysomelidae	<i>Altica cyanea</i> (Weber)	0.83± 0.36	1.08	0.83	1.08	9.31	12.12
Hymenoptera							
Vespidae	<i>Ropalidia brevita</i> (Das & Gupta)	1.33± 0.46	1.73	1.33	1.73		
Formicidae	<i>Camponotus</i> sp.	3.33± 0.46	4.33	3.33	4.33		
Apidae	<i>Apis dorsata</i> (Fabricius)	4.0± 0.57	5.21				
	<i>Apis mellifera</i> (Linnaeus)	14.83± 1.06	19.31				
	<i>Apis cerana</i> (Fabricius)	11.83± 1.06	15.40				
	<i>Trigona laeviceps</i> (Smith)	6.5± 0.95	8.46	37.16	48.39	41.82	54.45
Diptera							
Syrphidae	<i>Eristalis (Eoseristalis) cerealis</i> (Fabricius)	1.50± 0.5	1.95				
	<i>Eristalis (Eristalis) tenax</i> (Linnaeus)	2.16± 0.67	2.81				
	<i>Episyrphus balteatus</i> (De Geer)	12.50± 0.5	16.28				
	<i>Sphaerophoria (Sphaerophoria) indiana</i> (Bigot)	2.0± 0.5	2.60	18.16	23.65		
Muscidae	<i>Musca domestica</i> (Linnaeus)	5.66± 0.45	7.37	5.56	7.37	23.82	31.02
Locality-Majra							
Hemiptera							
Scutelleridae	<i>Chrysocoris purpureus</i> (Westwood)	2.16± 0.36	3.45	2.16	3.45	2.16	3.45
Coleoptera							
Cantharidae	<i>Chauliognathus pennsylvanicus</i> (De Geer)	0.83± 0.36	1.32	0.83	1.32		
Coccinellidae	<i>Coccinella septumpunctata</i> (Linnaeus)	3.83± 0.67	6.11				
	<i>Exochomus</i> sp.	2.16± 0.89	3.45	5.99	9.57		
Chrysomelidae	<i>Altica cyanea</i> (Weber)	1.83± 1.06	2.92	1.83	2.92	8.65	13.81
Hymenoptera							
Vespidae	<i>Ropalidia brevita</i> (Das & Gupta)	2.16± 0.67	3.45	2.16	3.45		
Formicidae	<i>Camponotus</i> sp.	3.83± 0.67	6.11	3.83	6.11		
Apidae	<i>Apis dorsata</i> (Fabricius)	9.16± 0.67	14.63				
	<i>Apis mellifera</i> (Linnaeus)	9.50± 0.5	15.17				
	<i>Apis cerana</i> (Fabricius)	9.16± 0.5	14.63				
	<i>Trigona laeviceps</i> (Smith)	4.66± 0.45	7.45	32.48	51.89	38.47	61.45
Diptera							
Syrphidae	<i>Eristalis (Eoseristalis) cerealis</i> (Fabricius)	2.66± 0.45	4.25				
	<i>Eristalis (Eristalis) tenax</i> (Linnaeus)	2.33± 0.46	3.72				
	<i>Episyrphus balteatus</i> (De Geer)	3.16± 0.67	5.04				

	<i>Sphaerophoria (Sphaerophoria) indiana</i> (Bigot)	1.33± 0.46	2.12	9.48	15.14		
Muscidae	<i>Musca domestica</i> (Linnaeus)	3.83± 0.67	6.11	3.83	6.11	13.31	21.26
Locality-Rajban							
Hemiptera							
Scutelleridae	<i>Chrysocoris purpureus</i> (Westwood)	1.5± 0.95	1.97	1.5	1.97	1.5	1.97
Coleoptera							
Cantharidae	<i>Chauliognathus pennsylvanicus</i> (De Geer)	2.0± 0.5	2.63	2.0	2.63		
Coccinellidae	<i>Coccinella septempunctata</i> (Linnaeus)	9.16± 0.5	12.05				
	<i>Exochomus</i> sp.	1.0± 0.57	1.32	10.16	13.37		
Chrysomelidae	<i>Altica cyanea</i> (Weber)	1.5± 0.5	1.97	1.5	1.97	13.66	17.97
Hymenoptera							
Vespidae	<i>Ropalidia brevita</i> (Das & Gupta)	1.0± 0.57	1.32	1.0	1.32		
Formicidae	<i>Camponotus</i> sp.	3.16± 0.67	4.16	3.16	4.16		
Apidae	<i>Apis dorsata</i> (Fabricius)	3.33± 0.46	4.38				
	<i>Apis mellifera</i> (Linnaeus)	13.5± 0.76	17.77				
	<i>Apis cerana</i> (Fabricius)	13.83± 0.67	18.21				
	<i>Trigona laeviceps</i> (Smith)	14.0± 0.57	18.43	44.66	58.79	48.82	64.27
Diptera							
Syrphidae	<i>Eristalis (Eoseristalis) cerealis</i> (Fabricius)	1.16± 0.67	1.52				
	<i>Eristalis (Eristalis) tenax</i> (Linnaeus)	1.33± 0.46	1.75				
	<i>Episyrphus balteatus</i> (De Geer)	4.83± 0.67	6.35				
	<i>Sphaerophoria (Sphaerophoria) indiana</i> (Bigot)	1.00± 0.57	1.32	8.32	11.03		
Muscidae	<i>Musca domestica</i> (Linnaeus)	3.66± 0.45	4.82	3.66	4.82	11.98	15.76
Locality-Sataun							
Hemiptera							
Scutelleridae	<i>Chrysocoris purpureus</i> (Westwood)	1.16± 0.67	2.30	1.16	2.30	1.16	2.30
Coleoptera							
Cantharidae	<i>Chauliognathus pennsylvanicus</i> (De Geer)	0.83± 0.67	1.64	0.83	1.64		
Coccinellidae	<i>Coccinella septempunctata</i> (Linnaeus)	6.66± 1.1	13.20				
	<i>Exochomus</i> sp.	0.66± 0.45	1.30	7.32	14.51		
Chrysomelidae	<i>Altica cyanea</i> (Weber)	0.83± 0.67	1.64	0.83	1.64	8.98	17.79
Hymenoptera							
Vespidae	<i>Ropalidia brevita</i> (Das & Gupta)	0.66± 1.30	1.30	0.66	1.30		
Formicidae	<i>Camponotus</i> sp.	1.66± 0.74	3.29	1.66	3.29		
Apidae	<i>Apis dorsata</i> (Fabricius)	6.5± 0.95	12.89				
	<i>Apis mellifera</i> (Linnaeus)	8.33± 0.70	16.51				
	<i>Apis cerana</i> (Fabricius)	11.83± 0.67	23.45				
	<i>Trigona laeviceps</i> (Smith)	3.33± 0.46	6.60	29.99	59.46	32.31	64.05
Diptera							
Syrphidae	<i>Eristalis (Eoseristalis) cerealis</i> (Fabricius)	0.83± 1.64	1.64				
	<i>Eristalis (Eristalis) tenax</i> (Linnaeus)	0.6± 0.45	1.30				
	<i>Episyrphus balteatus</i> (De Geer)	2.16± 0.67	4.28				
	<i>Sphaerophoria (Sphaerophoria) indiana</i> (Bigot)	1.83± 0.67	3.62	5.48	10.87		
Muscidae	<i>Musca domestica</i> (Linnaeus)	2.5± 0.5	4.96	2.50	4.96	7.98	15.82

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