

Studies on Diversity, Distribution and Relative Abundance of Insect Pollinators on Mango in Kyarda Doon Valley of District Sirmaur, Himachal Pradesh

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Abstract: The present studies were conducted on diversity, distribution and relative abundance of insect pollinators of mango in KyardaDoon valley of district Sirmaur, Himachal Pradesh. During the flowering period i.e. April - May 2019, collections were made regularly from 7 different localities viz. Kolar, Dhaulakuan, Majra, Paonta Sahib, Puruwala, Rajban and Sataun. Insect diversity studies showed a total of 23 species of insect pollinators belonging to 4 orders and 13 families of class Insecta. Of these, 11 species belonged to Diptera, 6 to Coleoptera, 4 to Hymenoptera and 2 to Hemiptera. Morphological features, genitalia and wing venation of the insect species were studied. Analysis of data on relative abundance of different insect pollinators revealed that dipterans were the most prominent insect visitors of mango flowers in all the localities i. e. Kolar (56.10%), Dhaulakuan (52.03%), Paonta Sahib (57.71%), Majra (47.62%), Puruwala (61.58%), Rajban (59.96%) and Sataun (64.85%). *Episyrphus balteatus* was the most abundant insect visitor to mango flowers in all the localities i. e. Kolar (16.06%), Dhaulakuan (18.09%), Paonta Sahib (13.12%), Majra (9.43%), Puruwala (27.44%), Rajban (20.11%) and Sataun (27.31%). Besides dipterans, coleopterans also constituted an important group of insect pollinators followed by hymenopterans and hemipterans.

Keywords: Insect pollinators, Diversity, Distribution, Relative Abundance, Mango, KyardaDoon Valley

1. Introduction

Pollination is the transfer of pollen grains from male anther to the female stigma of flowering plants. Plants depend on animal pollination through insects, birds, bats and others, while insects playing the major role (Abrol, 2012). Insects and other animal pollinators are play very important role in the production of healthy crops for food, fibers, edible oils, medicines, and other products. 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. Pollination is an ecosystem service that is a key to food security. Pollinators are essential for many fruit and vegetable crops. Most of the Crops like cashew, mango, high blush blueberry, cranberry, squash, cacao and cardamom are pollinated by wild insects having having a combined average value of \$1.2 billion (Gupta and Gupta, 1997).

The mango (*Mangifera indica* L.) has been acknowledged as an excellent fruit from the ancient times and has been liked by adults and infants alike. In India, the mango is produced in almost all the states. Production of this fruit has been found in the Uttar Pradesh, Andhra Pradesh, Bihar and Maharashtra, Gujarat, West Bengal, Karnataka and Kerala in the beginning. But now a days, most of the states like Punjab, Haryana and Himachal Pradesh have entered in its cultivation. Mango plants are pollinated by various pollinators and flies and stingless bees are thought to be the dominant pollinators of mangoes as they visit the flowers in large numbers and disperse between different trees.

2. Literature

Review of literature has indicated that various researchers has worked on the insect pollinators from different region of country e.g. Popenoe (1917) reported that honey bees were the important Hymenopteran insect visitors of the mango flowers. More than 550 species of flowering plants are visited by Dipterans that are potential pollinators. Mukherjee (1953) listed a number of important insects visiting mango which belonged to Lepidoptera, Hymenoptera, Coleoptera and Diptera including important genera like *Musca*, *Syrphus* and *Psychonosma*. Singh and Sturrock (1969) observed that flowers of mango had none of the characteristics of wind pollinated flower and considered mango to be an insect pollinated plant. Dag and Gazit (1996) observed insect pollinators visiting on mango bloom in 10 orchards located in all major mango growing areas at Israel. The species were found to play a significant role in mango pollination are; Dipterans: *Lucilia sericata*, *Chrysomya albiceps* (blow flies), *Musca domestica* (housefly) and several species of syrphidae family (hoverflies). Rajan and Reddy (2019) studied the pollination efficiency of two species viz. *Apis florea* (Hymenoptera) and *Chrysomya megacephala* (Diptera) and concluded that the Calliphorid fly (*C. megacephala*) was as good as wild bee (*A. florea*) in effecting mango pollination and enhancing fruit set.

The annual economic value of insect pollinators to agricultural productivity for the major crops cultivated in the state of Himachal Pradesh is US Dollar 365 million and it is US Dollar 6.93 million for mangoes in Himachal Pradesh (Klein *et al.*, 2007). This indicates that a total loss in local insect pollinators would result in a two - thirds reduction in fruit crop production (Partap and Tang, 2012). Keeping in

view the importance of insect pollinators in fruit crop production, present investigation was conducted on the diversity, distribution and relative abundance of different insect pollinators visiting mango crops in Kyarda Doon valley of district Sirmaur, Himachal Pradesh.

3. Materials and Methods

Studies on diversity, distribution and relative abundance of various insect pollinators of mango crop was made by collecting the flower visitors from different sites viz. Kolar, Dhaulakuan, Majra, Paonta Sahib, Puruwala, Rajban and Sataun located in Kyardadoon 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). 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). 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.

4. Results and Discussion

Diversity and distribution studies of insect pollinators on mango flowers revealed a total of 23 species from seven different localities i.e. Kolar, Dhaulakuan, Paonta Sahib, Majra, Puruwala, Rajban and Sataun. These 23 species belonged to four orders viz. Diptera, Hymenoptera, Coleoptera and Hemiptera. Out of 23 species, 11 belonged to order Diptera, 6 to Coleoptera, 4 to Hymenoptera and 2 to Hemiptera. Insect species belonging to Diptera are, *Penthetria melanaspis* (Wiedemann), *Tachina (Servillia) fulva* (Walker), *Mikiasp.* (Kowarz), *Episyrphus balteatus* (De Geer), *Eristalis (Eoseristalis) cerealis* (Fabricius), *Eristalis (Eristalis) tenax* (Linnaeus), *Syrirta pipiens* (Linnaeus), *Melanostoma orientale* (Wiedemann), *Sphaerophoria (Sphaerophoria) Indiana* (Bigot), *Musca domestica* (Linnaeus) and *Lucilia papuensis* (Macquart); to Coleoptera are, *Popillia cupricollis* (Hope), *Chauliognathus pennsylvanicus* (De Geer), *Coccinella septumpunctata* (Linnaeus), *Menochilus sexmaculatus* (Fabricius), *Anegleis cardoni* (Weise) and *Aulacophora foveicollis* (Lucas); to Hymenoptera are, *Polistes flavus* (Cresson), *Bombus haemorrhoidalis* (Smith), *Apis dorsata* (Fabricius) and *Apis mellifera* (Linnaeus) and to Hemiptera are, *Chrysocoris*

purpureus (Westwood) and *Nabis tibialis* (Distant) (Table 1).

Different investigations have reported different pollinators on various tropical and subtropical fruit crops. For example, a study on the insect visitors of mango was conducted by Singh and Singh (2003) in Nainital, Uttarakhand, India to evaluate the insect visitors of mango. Twenty - four insects were found on mango belonging to the orders Coleoptera, Diptera, Heteroptera, Hymenoptera and Lepidoptera.

Relative abundance studies revealed that dipterans were the most prominent insect visitors of mango flowers in all the localities i. e. Kolar (56.10%), Dhaulakuan (52.03%), Paonta Sahib (57.71%), Majra (47.62 %), Puruwala (61.58%), Rajban (59.56%) and Sataun (64.85%). The studies revealed that a total of 11 species of Diptera of which 6 species belonged to family Syrphidae, 2 to Tachinidae and 1 each to Bibionidae, Muscidae and Calliphoridae. Insects belonging to family Syrphidae were the most common in all the localities i. e. Kolar (45.50%), Dhaulakuan (41.01%), Paonta Sahib (42.97%), Majra (34.90%), Puruwala (47.60%), Rajban (43.54%) and Sataun (48.25%) followed by family Muscidae, Tachinidae, Bibionidae and Calliphoridae. *Episyrphus balteatus* was the most abundant insect visitor to mango flowers in all the 7 localities i. e. Kolar (11.83± 1.46, 16.06%), Dhaulakuan (15.8 ±1.3, 18.09%), Paonta Sahib (6.66± 1.25, 13.12%), Majra (6.66± 1.09, 9.43%), Puruwala (13.63± 1.08, 27.44%), Rajban (13.16± 1.06, 20.11%) and Sataun (11.5± 1.25, 27.31%). Six species of Coleoptera were also recorded of which 3 belonged to family Coccinellidae and 1 each to Scarabaeidae, Cantharidae and Chrysomelidae. Insects belonging to family Coccinellidae were the most common in all the localities i. e. Kolar (16.79%), Dhaulakuan (18.47%), Paonta Sahib (18.69%), Majra (21.23%), Puruwala (12.10%), Rajban (18.83%) and Sataun (13.84%) followed by family Cantharidae, Chrysomelidae and Scarabaeidae. *Coccinella septumpunctata* was the most abundant insect visitor to mango flowers in all the 7 localities i. e. Kolar (9.16± 0.50, 12.44%), Dhaulakuan (10.33±0.81, 11.80%), Paonta Sahib (6.33±0.46, 12.47%), Majra (10.33±0.81, 14.63%), Puruwala (4.83±0.67, 9.74%), Rajban (9.16±0.5, 14.0%) and Sataun (4.83±0.67, 11.46%). *Aulacophora foveicollis* and *Popilliacupricollis* was the least abundant insect pollinator from this order (Table 2).

Moreover, 4 species of Hymenoptera were observed of which 3 belonged to family Apidae and 1 to Vespidae. Insects belonging to family Apidae were the most common in all the localities i.e. Kolar (8.14%), Dhaulakuan (10.08%), Paonta Sahib (12.45%), Majra (13.20%), Puruwala (5.22%), Rajban (9.92%) and Sataun (9.87%) followed by family Vespidae i. e. Kolar (1.35%), Dhaulakuan (0.75%), Paonta Sahib (0.98%), Majra (2.12%), Puruwala (1.01%), Rajban (1.01%) and Sataun (1.56%). *Apis dorsata* was the most abundant insect visitor to mango flowers in all the 7 localities i. e. Kolar (3.33±0.46, 4.52%), Dhaulakuan (4.83±0.67, 5.52%), Paonta Sahib (3.33±0.74, 6.56%), Majra (4.66±0.74, 6.60%), Puruwala (1.50±0.5, 3.02%), Rajban (3.16±0.67, 4.83%) and Sataun (1.83± 0.36, 4.34%). It also has been observed that Hemiptera contributed least in all the 7 localities of Kyarda Doon valley of district Sirmauri. e. Kolar (4.06%), Dhaulakuan (3.98%), Paonta

Sahib (5.24%), Majra (2.50%), Puruwala (2.66%), Rajban (3.04%) and Sataun (1.56%). Relative abundance studies on insect pollinators of mango revealed 2 species of Hemiptera, of which one belonged to family Scutelleridae and the other to Nabidae. *Chrysocoris Purpureus* was the most abundant insect visitor from this order (Table 2)

Above studies are in conformity with the observations of some earlier investigations. For example, Singh *et al.* (1997) observed that highest number of insect species visiting mango flowers were from order Diptera (flies) of 17 species, followed by Coleoptera of 3 species, Hymenoptera of 3 species, Heteroptera of 3 species and Lepidoptera of 3 species. Jiron and Hedstrom (1985) observed that the most common visitors on the mango flowers were dipterans (Syrphidae, Calliphoridae and Sciaridae) 51.6% of all visitors; lepidopterans (Nymphalidae and Lycaenidae) 33% coleopterans (Cantharidae) 3.8%, and hymenopteran (Apidae) 11.6%.

5. Conclusion

From the above study it has been recorded that Mango flowers were highly attractive to wide variety of insects. Dipterans were the most prominent insect visitors of mango flowers in all the localities. Among all the insect pollinators, *Episyrphus balteatus* was the most abundant insect visitor to mango flowers in all the localities. Besides dipterans, coleopterans also constituted an important group of insect pollinators followed by hymenopterans and hemipterans.

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Table 1: Systematic list of insect pollinators of Mango in KyardaDoon valley of District Sirmaur, Himachal Pradesh

ORDER	FAMILY	FAUNA
HEMIPTERA	SCUTELLERIDAE NABIDAE	1. <i>Chrysocoris purpureus</i> (Westwood) 2. <i>Nabis tibialis</i> (Distant)
COLEOPTERA	SCARABAEIDAE CANTHARIDAE COCCINELLIDAE CHRYSOMELIDAE	3. <i>Popillia cupricollis</i> (Hope) 4. <i>Chauliognathus pennsylvanicus</i> (De Geer) 5. <i>Coccinella septumpunctata</i> (Linnaeus) 6. <i>Menochilus sexmaculatus</i> (Fabricius) 7. <i>Anegleis cardoni</i> (Weise) 8. <i>Aulacophora foveicollis</i> (Lucas)
HYMENOPTERA	VESPIDAE APIDAE	9. <i>Polistes flavus</i> (Cresson) 10. <i>Bombus haemorrhoidalis</i> (Smith)

		11. <i>Apis dorsata</i> (Fabricius) 12. <i>Apis mellifera</i> (Linnaeus)
DIPTERA	BIBIONIDAE TACHINIDAE	13. <i>Penthetria melanaspis</i> (Wiedemann) 14. <i>Tachina (Servillia) fulva</i> (Walker) 15. <i>Mikia</i> sp. (Kowarz)
	SYRPHIDAE	16. <i>Episyrphus balteatus</i> (De Geer) 17. <i>Eristalis (Eoseristalis) cerealis</i> (Fabricius) 18. <i>Eristalis (Eristalis) tenax</i> (Linnaeus) 19. <i>Syrirta pipiens</i> (Linnaeus) 20. <i>Melanostoma orientale</i> (Wiedemann)
	MUSCIDAE CALLIPHORIDAE	21. <i>Sphaerophoria (Sphaerophoria) Indiana</i> (Bigot) 22. <i>Musca domestica</i> (Linnaeus) 23. <i>Lucilia papuensis</i> (Macquart)

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

Order/family	Genus/Species	X±SE	Percent population	Family Number	Family percentage	Order number	Order percentage
Locality – Kolar							
HEMIPTERA							
Scutelleridae	<i>Chrysocoris purpureus</i> (Westwood)	1.83±0.67	2.48	1.83	2.48		
Nabidae	<i>Nabistibialis</i> (Distant)	1.16±0.67	1.57	1.16	1.57	2.99	4.06
COLEOPTERA							
Scarabaeidae	<i>Popilliacupricollis</i> (Hope)	1.5±0.5	2.04	1.5	2.04		
Cantharidae	<i>Chauliognathus pennsylvanicus</i> (De Geer)	5.5±0.5	7.47	5.5	7.47		
Coccinellidae	<i>Coccinellaseptumpunctata</i> (Linnaeus)	9.16±0.50	12.44				
	<i>Menochilus sexmaculatus</i> (Fabricius)	3.50±0.95	4.75				
	<i>Anegleiscardoni</i> (Weise)	1.17±0.67	1.58	13.83	16.79		
Chrysomelidae	<i>Aulacophora foveicollis</i> (Lucas)	1.5±0.5	2.04	1.5	2.04	22.33	30.33
HYMENOPTERA							
Vespidae	<i>Polistes flavus</i> (Cresson)	1.0±0.57	1.35	1.0	1.35		
Apidae	<i>Bombus haemorrhoidalis</i> (Smith)	0.50±0.5	0.68				
	<i>Apis dorsata</i> (Fabricius)	3.33±0.46	4.52				
	<i>Apis mellifera</i> (Linnaeus)	2.16±0.67	2.93	5.99	8.14	6.99	9.49
DIPTERA							
Bibionidae	<i>Penthetria melanaspis</i> (Wiedemann)	1.5±0.95	2.03	1.5	2.03		
Tachinidae	<i>Tachina (Servillia) fulva</i> (Walker)	1.0±0.81	1.35				
	<i>Mikiasp.</i> (Kowarz)	0.83±0.67	1.13	1.83	2.48		
Syrphidae	<i>Episyrphus balteatus</i> (De Geer)	11.83±1.46	16.06				
	<i>Eristalis (Eoseristalis) cerealis</i> (Fabricius)	5.33±0.7	7.24				
	<i>Eristalis (Eristalis) tenax</i> (Linnaeus)	6.00±0.57	8.15				
	<i>Syrirta pipiens</i> (Linnaeus)	6.00±0.81	8.15				
	<i>Melanostoma orientale</i> (Wiedemann)	3.33±0.93	4.52				
	<i>Sphaerophoria (Sphaerophoria) Indiana</i> (Bigot)	1.00±0.57	1.35	33.49	45.50		
Muscidae	<i>Musca domestica</i> (Linnaeus)	3.83±0.88	5.20	3.83	5.20		
Calliphoridae	<i>Lucilia papuensis</i> (Macquart)	0.66±0.45	0.89	0.66	0.89	41.31	56.10
Locality – Dhulakuan							
HEMIPTERA							
Scutelleridae	<i>Chrysocoris purpureus</i> (Westwood)	1.33±0.46	1.52	1.33	1.52		
Nabidae	<i>Nabistibialis</i> (Distant)	2.16±0.67	2.47	2.16	1.47	3.49	3.98
COLEOPTERA							
Scarabaeidae	<i>Popilliacupricollis</i> (Hope)	2.66±0.93	3.04	2.66	3.04		
Cantharidae	<i>Chauliognathus pennsylvanicus</i> (De Geer)	5.66±1.24	6.47	5.66	6.47		
Coccinellidae	<i>Coccinellaseptumpunctata</i> (Linnaeus)	10.33±0.81	11.80				
	<i>Menochilus sexmaculatus</i> (Fabricius)	4.50±0.76	5.14				
	<i>Anegleiscardoni</i> (Weise)	1.33±0.46	1.52	16.16	18.47		
Chrysomelidae	<i>Aulacophora foveicollis</i> (Lucas)	4.5±0.5	5.14	4.5	5.14	28.98	33.12
HYMENOPTERA							
Vespidae	<i>Polistes flavus</i> (Cresson)	0.66±0.45	0.75	0.66	0.75		
Apidae	<i>Bombus haemorrhoidalis</i> (Smith)	0.33±0.46	0.38				
	<i>Apis dorsata</i> (Fabricius)	4.83±0.67	5.52				
	<i>Apis mellifera</i> (Linnaeus)	3.66±0.45	4.18	8.82	10.08	10.83	12.38
DIPTERA							
Bibionidae	<i>Penthetria melanaspis</i> (Wiedemann)	1.16±0.67	1.33	1.16	1.33		
Tachinidae	<i>Tachina (Servillia) fulva</i> (Walker)	0.83±0.67	0.95				
	<i>Mikiasp.</i> (Kowarz)	1.50±0.76	1.71	2.33	2.66		
Syrphidae	<i>Episyrphus balteatus</i> (De Geer)	15.83±1.3	18.09				
	<i>Eristalis (Eoseristalis) cerealis</i> (Fabricius)	4.56±0.5	5.21				

	<i>Eristalis (Eristalis) tenax</i> (Linnaeus)	4.83± 0.67	5.52				
	<i>Syrittapiens</i> (Linnaeus)	6.5± 0.95	7.43				
	<i>Melanostomaorientale</i> (Wiedemann)	2.16± 0.67	2.47				
	<i>Sphaerophoria (Sphaerophoria) indiana</i> (Bigot)	2.0± 0.81	2.29	35.88	41.01		
Muscidae	<i>Muscadomestica</i> (Linnaeus)	4.5± 0.95	5.14	4.5	5.14		
Calliphoridae	<i>Luciliapapuensis</i> (Macquart)	1.66 ±0.45	1.89	1.66	1.89	45.53	52.03
Locality – Paonta Sahib							
HEMIPTERA							
Scutelleridae	<i>Chrysocorispurpureus</i> (Westwood)	1.16± 0.36	2.28	1.16	2.28		
Nabidae	<i>Nabistibialis</i> (Distant)	1.5± 0.5	2.95	1.5	2.95	2.66	5.24
COLEOPTERA							
Scarabaeidae	<i>Popilliacupricollis</i> (Hope)	1.0± 0.57	1.97	1.0	1.97		
Cantharidae	<i>Chauliognathuspennsylvanicus</i> (De Geer)	6.16± 0.75	12.14	6.16	12.14		
Coccinellidae	<i>Coccinellaseptumpunctata</i> (Linnaeus)	6.33± 0.46	12.47				
	<i>Menochilussexmaculatus</i> (Fabricius)	2.83± 0.67	5.57				
	<i>Anegleiscardoni</i> (Weise)	0.33± 0.46	0.65	9.49	18.69		
Chrysomelidae	<i>Aulacophorafoveicollis</i> (Lucas)	1.33± 0.46	2.62	1.33	2.62	17.98	35.42
HYMENOPTERA							
Vespidae	<i>Polistesflavus</i> (Cresson)	0.5± 0.5	0.98	0.5	0.98		
Apidae	<i>Bombushaemorrhoidalis</i> (Smith)	0.33± 0.46	0.65				
	<i>Apis dorsata</i> (Fabricius)	3.33± 0.74	6.56				
	<i>Apis mellifera</i> (Linnaeus)	2.66± 0.45	5.24	6.32	12.45	6.82	13.43
DIPTERA							
Bibionidae	<i>Penthetriamelanaspis</i> (Wiedemann)	2.16± 0.36	4.25	2.16	4.25		
Tachinidae	<i>Tachina (Servillia) fulva</i> (Walker)	0.5± 0.5	0.98				
	<i>Mikiasp.</i> (Kowarz)	0.50± 0.50	0.98	1.0	1.96		
Syrphidae	<i>Episyrphusbalteatus</i> (De Geer)	6.66± 1.25	13.12				
	<i>Eristalis (Eoseristalis) cerealis</i> (Fabricius)	3.38± 0.48	7.55				
	<i>Eristalis (Eristalis) tenax</i> (Linnaeus)	2.83± 0.67	5.57				
	<i>Syrittapiens</i> (Linnaeus)	4.5± 0.76	8.87				
	<i>Melanostomaorientale</i> (Wiedemann)	1.66± 0.93	3.27				
	<i>Sphaerophoria (Sphaerophoria) indiana</i> (Bigot)	2.33± 0.46	4.59	21.81	42.97		
Muscidae	<i>Muscadomestica</i> (Linnaeus)	3.16± 1.6	6.22	3.16	6.22		
Calliphoridae	<i>Luciliapapuensis</i> (Macquart)	1.16± 0.67	2.28	1.16	2.28	29.29	57.71
Locality – Majra							
HEMIPTERA							
Scutelleridae	<i>Chrysocorispurpureus</i> (Westwood)	0.5± 0.5	0.70	0.5	0.70		
Nabidae	<i>Nabistibialis</i> (Distant)	1.33± 0.46	1.88	1.33	1.88	1.83	2.50
COLEOPTERA							
Scarabaeidae	<i>Popilliacupricollis</i> (Hope)	3.33± 0.74	0.46	3.33	0.46		
Cantharidae	<i>Chauliognathuspennsylvanicus</i> (De Geer)	3.5± 0.76	4.95	3.5	4.95		
Coccinellidae	<i>Coccinellaseptumpunctata</i> (Linnaeus)	10.33± 0.81	14.63				
	<i>Menochilussexmaculatus</i> (Fabricius)	3.16± 1.02	4.47				
	<i>Anegleiscardoni</i> (Weise)	1.50± 0.50	2.12	14.99	21.23		
Chrysomelidae	<i>Aulacophorafoveicollis</i> (Lucas)	2.5± 0.5	3.45	2.5	3.45	24.32	34.45
HYMENOPTERA							
Vespidae	<i>Polistesflavus</i> (Cresson)	1.5 ±0.5	2.12	1.5	2.12		
Apidae	<i>Bombushaemorrhoidalis</i> (Smith)	0.16± 0.36	0.23				
	<i>Apis dorsata</i> (Fabricius)	4.66± 0.74	6.60				
	<i>Apis mellifera</i> (Linnaeus)	4.50± 0.5	6.37	9.32	13.20	10.82	15.32
DIPTERA							
Bibionidae	<i>Penthetriamelanaspis</i> (Wiedemann)	2.5± 0.5	3.54	2.5	3.54		
Tachinidae	<i>Tachina (Servillia) fulva</i> (Walker)	0.83± 0.67	1.17				
	<i>Mikiasp.</i> (Kowarz)	1.33± 0.46	1.88	2.16	3.05		
Syrphidae	<i>Episyrphusbalteatus</i> (De Geer)	6.66± 1.09	9.43				
	<i>Eristalis (Eoseristalis) cerealis</i> (Fabricius)	2.66± 0.45	3.77				
	<i>Eristalis (Eristalis) tenax</i> (Linnaeus)	3.83± 0.67	5.42				
	<i>Syrittapiens</i> (Linnaeus)	6.33± 0.46	8.96				
	<i>Melanostomaorientale</i> (Wiedemann)	2.66± 0.74	3.77				
	<i>Sphaerophoria (Sphaerophoria) indiana</i> (Bigot)	2.50± 0.5	3.54	24.64	34.90		
Muscidae	<i>Muscadomestica</i> (Linnaeus)	3.66± 0.74	5.18	3.66	5.18		
Calliphoridae	<i>Luciliapapuensis</i> (Macquart)	0.66± 0.45	0.93	0.66	0.93	33.62	47.62
Locality – Puruwala							
HEMIPTERA							
Scutelleridae	<i>Chrysocorispurpureus</i> (Westwood)	0.66± 0.45	1.33	0.66	1.33		
Nabidae	<i>Nabistibialis</i> (Distant)	0.66± 0.45	1.33	0.66	1.33	1.32	2.66
COLEOPTERA							

Scarabaeidae	<i>Popilliacupricollis</i> (Hope)	2.33± 0.46	4.70	2.33	4.70		
Cantharidae	<i>Chauliognathuspennsylvanicus</i> (De Geer)	3.5± 0.76	7.06	3.50	7.06		
Coccinellidae	<i>Coccinellaseptumpunctata</i> (Linnaeus)	4.83± 0.67	9.74				
	<i>Menochilussexmaculatus</i> (Fabricius)	1.0± 0.57	2.01				
	<i>Anegleiscardoni</i> (Weise)	0.17± 0.36	0.34	6.0	12.1		
Chrysomelidae	<i>Aulacophorafoveicollis</i> (Lucas)	3.00± 0.81	6.05	3.00	6.05	14.83	29.91
HYMENOPTERA							
Vespidae	<i>Polistesflavus</i> (Cresson)	0.5± 0.5	1.01	0.50	1.01		
Apidae	<i>Bombushaemorrhoidalis</i> (Smith)	0.66± 0.45	1.33				
	<i>Apis dorsata</i> (Fabricius)	1.50± 0.5	3.02				
	<i>Apismellifera</i> (Linnaeus)	0.33± 0.57	0.66	2.59	5.22	3.09	6.23
DIPTERA							
Bibionidae	<i>Penthetriamelanaspis</i> (Wiedemann)	1.33± 0.74	2.68	1.33	2.68		
Tachinidae	<i>Tachina (Servillia) fulva</i> (Walker)	0.5± 0.5	1.01				
	<i>Mikiasp.</i> (Kowarz)	1.33± 0.74	2.68	1.83	3.69		
Syrphidae	<i>Episyrphusbalteatus</i> (De Geer)	13.63± 1.08	27.44				
	<i>Eristalis (Eoseristalis) cerealis</i> (Fabricius)	2.0± 0.57	4.03				
	<i>Eristalis (Eristalis) tenax</i> (Linnaeus)	2.66± 0.74	5.34				
	<i>Syrittapipiens</i> (Linnaeus)	2.33± 0.74	4.70				
	<i>Melanostomaorientale</i> (Wiedemann)	1.16± 0.67	2.34				
	<i>Sphaerophoria (Sphaerophoria) indiana</i> (Bigot)	1.83± 0.67	3.69	23.61	47.6		
Muscidae	<i>Muscadomestica</i> (Linnaeus)	3.16± 0.67	6.37	3.16	6.37		
Calliphoridae	<i>Luciliapapuensis</i> (Macquart)	0.5± 0.5	1.01	0.5	1.01	30.43	61.38
LOCALITY – RAJBAN							
HEMIPTERA							
Scutelleridae	<i>Chrysocoris purpureus</i> (Westwood)	1.33± 0.46	2.03	1.33	2.03		
Nabidae	<i>Nabistibialis</i> (Distant)	0.66± 0.45	1.01	0.66	1.01	1.99	3.04
COLEOPTERA							
Scarabaeidae	<i>Popilliacupricollis</i> (Hope)	0.66± 0.45	1.01	0.66	1.01		
Cantharidae	<i>Chauliognathuspennsylvanicus</i> (De Geer)	2.5± 0.5	3.82	2.5	3.82		
Coccinellidae	<i>Coccinellaseptumpunctata</i> (Linnaeus)	9.16± 0.5	14.0				
	<i>Menochilussexmaculatus</i> (Fabricius)	2.16± 0.67	3.30				
	<i>Anegleiscardoni</i> (Weise)	1.0± 0.81	1.53	12.32	18.83		
Chrysomelidae	<i>Aulacophorafoveicollis</i> (Lucas)	1.83± 0.67	2.79	1.83	2.79	17.31	26.46
HYMENOPTERA							
Vespidae	<i>Polistesflavus</i> (Cresson)	0.66± 1.01	1.01	0.66	1.01		
Apidae	<i>Bombushaemorrhoidalis</i> (Smith)	1.00± 0.57	1.52				
	<i>Apis dorsata</i> (Fabricius)	3.16± 0.67	4.83				
	<i>Apismellifera</i> (Linnaeus)	2.33± 0.46	3.56	6.49	9.92	7.15	10.91
DIPTERA							
Bibionidae	<i>Penthetriamelanaspis</i> (Wiedemann)	0.83± 0.67	1.26	0.83	1.26		
Tachinidae	<i>Tachina (Servillia) fulva</i> (Walker)	1.5± 0.5	2.29				
	<i>Mikiasp.</i> (Kowarz)	2.16± 0.67	3.30	3.66	5.59		
Syrphidae	<i>Episyrphusbalteatus</i> (De Geer)	13.16± 1.06	20.11				
	<i>Eristalis (Eoseristalis) cerealis</i> (Fabricius)	3.5± 0.5	5.35				
	<i>Eristalis (Eristalis) tenax</i> (Linnaeus)	2.5± 0.5	3.82				
	<i>Syrittapipiens</i> (Linnaeus)	4.66± 0.93	7.12				
	<i>Melanostomaorientale</i> (Wiedemann)	2.5± 0.5	3.82				
	<i>Sphaerophoria (Sphaerophoria) indiana</i> (Bigot)	2.16± 0.67	3.30	28.48	43.54		
Muscidae	<i>Muscadomestica</i> (Linnaeus)	4.83± 0.67	7.38	4.83	7.38		
Calliphoridae	<i>Luciliapapuensis</i> (Macquart)	1.16± 0.67	1.77	1.16	1.77	38.96	59.56
LOCALITY – SATAUN							
HEMIPTERA							
Scutelleridae	<i>Chrysocoris purpureus</i> (Westwood)	0.33± 0.46	0.78	0.33	0.78		
Nabidae	<i>Nabistibialis</i> (Distant)	0.33± 0.46	0.78	0.33	0.78	0.66	1.56
COLEOPTERA							
Scarabaeidae	<i>Popilliacupricollis</i> (Hope)	1.16± 0.67	2.75	1.16	2.75		
Cantharidae	<i>Chauliognathuspennsylvanicus</i> (De Geer)	1.33± 0.74	3.15	1.33	3.15		
Coccinellidae	<i>Coccinellaseptumpunctata</i> (Linnaeus)	4.83± 0.67	11.46				
	<i>Menochilussexmaculatus</i> (Fabricius)	0.83± 0.67	1.97				
	<i>Anegleiscardoni</i> (Weise)	0.17± 0.36	0.41	5.83	13.84		
Chrysomelidae	<i>Aulacophorafoveicollis</i> (Lucas)	1.0± 0.5	2.37	1.0	2.37	9.32	22.13
HYMENOPTERA							
Vespidae	<i>Polistesflavus</i> (Cresson)	0.66± 0.45	1.56	0.66	1.56		
Apidae	<i>Bombushaemorrhoidalis</i> (Smith)	1.50± 0.5	3.56				
	<i>Apis dorsata</i> (Fabricius)	1.83± 0.36	4.34				
	<i>Apismellifera</i> (Linnaeus)	0.83± 0.36	1.97	4.16	9.87	4.82	11.44

DIPTERA							
Bibionidae	<i>Penthetriamelanaspis</i> (Wiedemann)	0.66± 0.74	1.56	0.66	1.56		
Tachinidae	<i>Tachina (Servillia) fulva</i> (Walker)	0.33± 0.46	0.78				
	<i>Mikiasp.</i> (Kowarz)	2.0± 0.57	4.74	2.33	5.52		
Syrphidae	<i>Episyrphusbalteatus</i> (De Geer)	11.5± 1.25	27.31				
	<i>Eristalis (Eoseristalis) cerealis</i> (Fabricus)	2.0± 0.57	4.74				
	<i>Eristalis (Eristalis) tenax</i> (Linnaeus)	2.16± 0.67	5.12				
	<i>Syrittapipiens</i> (Linnaeus)	2.16± 0.67	5.12				
	<i>Melanostomaorientale</i> (Wiedemann)	1.0± 0.81	2.37				
	<i>Sphaerophoria (Sphaerophoria) indiana</i> (Bigot)	1.50± 0.5	3.56	20.32	48.25		
Muscidae	<i>Muscadomestica</i> (Linnaeus)	3.5± 0.5	8.31	3.5	8.31		
Calliphoridae	<i>Luciliapapuensis</i> (Macquart)	0.5± 0.5	1.19	0.5	1.19	27.31	64.85