



## DIVERSITY AND DISTRIBUTION OF INSECT POLLINATORS ON VARIOUS TEMPERATE FRUIT CROPS IN HIMACHAL HIMALAYA, INDIA

\*Hem Raj & Mattu, V. K.

G.B. Pant Memorial Govt. College Rampur Bsr. Shimla-172 001 (HP), India.

\*Corresponding Authors' Email: suryahemraj@gmail.com

### ABSTRACT

Pollinator diversity and distribution studies were conducted on temperate fruit crops in different parts of Himachal Himalaya. Various crops investigated were: apple (*Malus domestica* Borckh), pear (*Pyrus communis* Linn.), cherry (*Prunus avium* Linn.), peach (*Prunus persica* Batsch), plum (*Prunus domestica* Linn.) and almond (*Prunus amygdalus* Batsch). Various temperate fruit crop orchards were located at different altitudes viz., Arki (1104 m), Deothi (1394 m), Kandaghat (1423 m), Wakanaghat (1456 m), Shoghi (1857 m), Theog (2305 m), Shilaroo (2409 m), Fagu 2411 m), Chharabra (2479 m), Matiana (2514 m) and Narkanda (2648 m) in Himachal Himalaya. Pollinator diversity studies on different temperate fruit crops revealed the presence of 70 species of insect visitors belonging to 6 orders and 27 families of class Insecta. Of these, 24 species belonged to Hymenoptera, 24 to Diptera, 16 to Lepidoptera, 3 to Coleoptera, 2 to Hemiptera and 1 to Thysanoptera. Apple (*Malus domestica* Borckh) flowers were visited by 46 species of pollinators belonging to 5 orders and 17 families of class insecta. Of these, 16 species belonged to Hymenoptera, 18 to Diptera, 8 to Lepidoptera, 3 to Coleoptera and 1 to order Thysanoptera. Pear (*Pyrus communis* Linn.) flowers were visited by 33 species of insects belonging to 4 orders and 16 families of class Insecta. Of these, 13 species belonged to Hymenoptera, 11 to Diptera, 6 to Lepidoptera and 3 to Coleoptera. Cherry (*Prunus avium* L.) flowers were visited by 31 species of insects belonging to 5 orders and 13 families of class Insecta. Of these, 12 species belonged to Hymenoptera, 10 to Diptera, 6 to Lepidoptera, 2 to Hemiptera and 1 to Coleoptera. Peach (*Prunus persica* Batsch) flowers were visited by 40 species of insects belonging to 5 orders and 24 families of class Insecta. Of these, 15 species belonged to Hymenoptera, 12 to Diptera, 9 to Lepidoptera, 3 to Coleoptera and 1 to Hemiptera. Plum (*Prunus domestica* L.) bloom showed that they were visited by 19 species of insects belonging to 4 orders and 11 families of class Insecta. Of these, 8 species belonged to Hymenoptera, 5 to Diptera, 5 to Lepidoptera and 1 to Coleoptera. Almond (*Prunus amygdalus* Batsch) flowers were visited by 30 species of insects belonging to 4 orders and 17 families of class Insecta. Of these, 10 species belonged to Hymenoptera, 12 to Diptera, 5 to Lepidoptera and 3 to Coleoptera.

**KEY WORDS:**-Diversity and distribution, Insect pollinators, Temperate fruit crops, Western Himalaya.

### INTRODUCTION

Insects are the most commonly occurring pollinators of many agricultural and horticultural crops. Different kinds of insect pollinators such as bees, flies, beetles, butterflies, moths and wasps are important pollinators of many crops. Among insects, bees are more effective pollinators than other insects because, unlike other insects, they are social and collect nectar and pollen not only to satisfy their own needs but to feed their young; their body hairs help transfer pollen from one flower to another; they show flower constancy and move from one flower to another of the same species; and many species can be reared and managed for pollination (Mattu, 2010). Pollinators are essential for the reproduction of many wild flowers and crops: for one out of every three bites eaten, one can thank a bee, butterfly, bat, bird or other pollinator. Any loss in biodiversity is a matter of public concern, but losses of pollinating insects may be particularly troublesome because of the potential effects on plant reproduction and hence on food supply security. Many agricultural crops and natural plant populations are dependent on pollination and often on the services provided by wild, unmanaged, pollinator communities (Free, 1993; Kluser and Peduzzi, 2007).

### METHODOLOGY

Diversity and distribution studies were conducted on temperate fruit crops in different parts of Himachal Himalaya on insect pollinators. Various crops investigated were: apple (*Malus domestica* Borckh), pear (*Pyrus communis* Linn.), cherry (*Prunus avium* Linn.), peach (*Prunus persica* Batsch), plum (*Prunus domestica* Linn.) and almond (*Prunus amygdalus* Batsch). Diversity studies were conducted on temperate fruit crops in orchards located at different altitudes viz., Arki (1104 m), Deothi (1394 m), Kandaghat (1423 m), Wakanaghat (1456 m), Shoghi (1857 m), Theog (2305 m), Shilaroo (2409 m), Fagu 2411 m), Chhrabra (2479 m), Matiana (2514 m) and Narkanda (2648 m) in Himachal Himalaya. Different experimental orchards belonging to various fruit crops had different varieties, for example, apple orchards had more than 200 trees belonging to Royal Delicious, Red Gold, Golden Delicious and Red Delicious varieties, whereas, main varieties of pear in experimental orchards were: Sand Pears, Red Bartlett and Early China. Cherry orchards had more than 100 trees mostly belonging to Early Rivers variety. In addition, plum orchards had more than 150 trees of Santa Rosa and Starking Delicious varieties. Main varieties of peach were: Alton and Elberta Giant, whereas,

the varieties of almond studied were: Katha and Dhebar. Studies on diversity and distribution of various insect visitors to temperate fruit crops were made by taking photos of living insects on flowers and collecting some pollinators present in large numbers at different orchards situated in Himachal Himalaya.

#### Collection of Insect Pollinators

The important groups covered were: Hymenoptera, Diptera, Lepidoptera, Coleoptera, Hemiptera and Thysanoptera. For sampling different insect species, following methods were used:

##### I. Hand Picking Method

This method was quite suitable for the insect pollinators like small coleopterans, hymenopterans (Jonathan, 1990), and dipterans (Joseph, 1990).

##### II. Sweeping Method

This method was used for the collection of following groups of insects *i.e.* Coleoptera, Lepidoptera and Hymenoptera (Arora, 1990).

##### III. Beating Method

This method was employed to dislodge insect pollinators from foliage or trees of temperate fruit crops (Ghosh, 1990).

##### IV Aerial Netting Method

Aerial netting method was widely used to collect free flying insect pollinators like hymenopterans, lepidopterans and dipterans (Arora, 1990; Joseph, 1990). Insect pollinators collected by aerial netting method were then killed with the help of a killing bottle. The killing bottle was changed each day during the field collection (Sengupta, 1990).

##### V Aspirator Method

Small active insect pollinators belonging to order Diptera, Coleoptera and Hymenoptera were collected with the help of aspirator method and then the entire contents were put into a killing bottle (Ghosh, 1990).

#### Preservation of Insect Pollinators

Different methods were followed for the preservation of insect pollinators belonging to different groups.

##### 1. Hymenoptera

Hymenopteran insect pollinators were killed by exposure to cyanide vapours and preserved in 90% ethyl alcohol (Jonathan, 1990).

##### 2. Lepidoptera

Lepidopteran pollinators like butterflies and moths were killed in a killing jar containing liquid benzene and ethyl acetate. Butterflies were pinned by stainless steel pin nos. 3 and 5 and were quite suitable for most of the species, whereas, no. 20 for the small butterflies (Arora, 1990).

##### 3. Coleoptera

After killing, Coleopteran were relaxed in relaxing chamber, (Phenol: water) and mounted on cards and kept in a dry chamber for a few days. After this, they were shifted for permanent storage to a wooden cabinet. (Sengupta and Mukhopadhyaya, 1990).

##### 4. Thysanoptera

Insect pollinators were killed and preserved in 80% alcohol and mounted directly on to a slide in Canada Balsam (Ghosh, 1990).

##### 5. Diptera

Small pollinator flies were preserved in 70% ethyl alcohol and before pinning, they were dried by passing through ethyl ether and xylol. Dipterous larvae and pupae were preserved in 70% ethyl alcohol (Joseph, 1990).

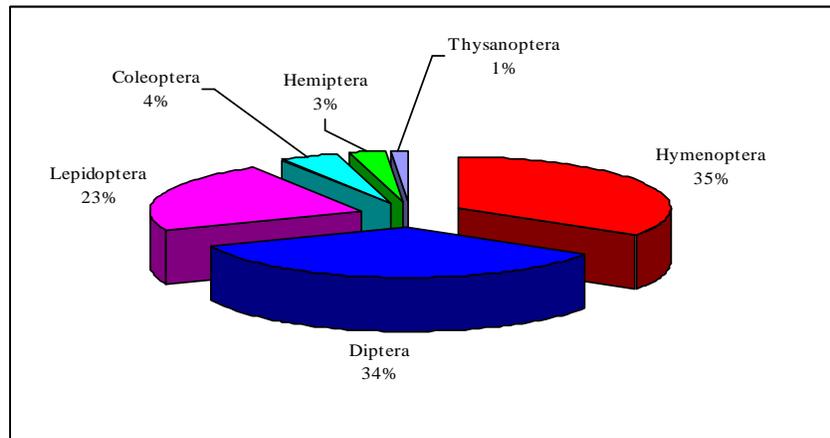
#### RESULTS & DISCUSSION

Pollinator diversity studies on various temperate fruit crops *viz.*, apple, pear, cherry, peach, plum and almond in Himachal Himalaya revealed the presence of 70 species of insect visitors belonging to 6 orders and 27 families of class Insecta. Of these, 24 species belonged to Hymenoptera, 24 to Diptera, 16 to Lepidoptera, 3 to Coleoptera, 2 to Hemiptera and 1 to Thysanoptera (Table 1, Fig. 1). A similar survey by Hong *et al.* (1989) revealed a total of 88 species of pollinators on apple, pear and peach flowers in North Korea. Thapa (2006) observed the presence of 50 species of insect pollinators on flowers of different crops in Nepal and found that honeybees contributed 80 % of the total insect pollination. Crop wise diversity of insect pollinators in Himachal Himalaya has been summarized as follows:

##### Apple (*Malus domestica* Borkh)

Insect diversity studies showed that apple flowers were visited by 46 species of insects belonging to 5 orders and 17 families of class insecta. Of these, 16 species belonged to Hymenoptera, 18 to Diptera, 8 to Lepidoptera, 3 to Coleoptera and 1 to order Thysanoptera. Comparative abundance studies on different insect pollinators in different experimental orchards have been summarized as follows:

It has been observed that Hymenoptera was represented by 6 families *viz.*, Apidae, Vespidae, Halictidae, Andrenidae, Formicidae and Pteromalidae. Hymenopterans were represented by species like *Apis cerana*, *A. mellifera*, *Bombus tunicatus*, *B. haemorrhoidalis*, *Vespa mandarina*, *V. velutina*, *V. flaviceps*, *Polistes maculipennis*, *Halictus dasygaster*, *Camponotus* sp. *etc.* Of the dipterans, species like *Eristalis tenax*, *E. himalayensis*, *E. cerealis*, *E. angustimarginalis*, *E. arvorum*, *Metasyrphus corollae*, *Scaeva pyrastris*, *Musca domestica*, *Fannia domestica*, *Calliphora vicina* *etc.* spread over families Syrphidae, Cordiluridae, Calliphoridae and Dolichopodidae were recorded as pollinators of apple crop. Moreover, 8 species of lepidopterans were spread over families like Pieridae, Nymphalidae and Noctuidae. Order Coleoptera was represented by two families *viz.*, Coccinellidae and Chrysomelidae. In addition, a single species of thrips belonging to order Thysanoptera was also recorded as pollinator of apple crop in Himachal Himalaya (Table 1). Present diversity studies on the apple bloom are in accordance with the earlier investigations of Verma and Chauhan (1985) who recorded 44 species of insect pollinators on the crop in Shimla hills, of which 16 species belonged to Hymenoptera, 11 to Diptera, 9 to Lepidoptera, 7 to Coleoptera and 1 to Hemiptera. Similarly, Kumar (1988) observed 16 species of bees visiting apple bloom in Solan area of Himachal Pradesh.



**FIGURE 1:** Percentage of Insect pollinator species on temperate fruit crops in Himachal Himalaya

### **Pear (*Pyrus communis* Linn.)**

Pollinator diversity studies on pome fruits crops showed that pear flowers were visited by 33 species of insects belonging to 4 orders and 16 families of class Insecta. Of these, 13 species belonged to Hymenoptera, 11 to Diptera, 6 to Lepidoptera and 3 to Coleoptera.

Of 13 species of Hymenoptera, 5 belonged to family Vespidae *i.e.* *Vespa magnifica*, *Vespa auraria*, *Vespa flaviceps*, *Polistes maculipennis* and *Polistes sp.*, 2 each to Apidae *i.e.* *Apis cerana* and *Apis mellifera*; Bombidae *i.e.* *Bombus tunicatus* and *Bombus sp.* and Halictidae *i.e.* *Halictus dasygaster* and *Halictus sp.*, one each to Xylocopidae *i.e.* *Xylocopa fenestrata* and Formicidae *i.e.* *Camponotus sp.* Of 11 species of Diptera, 6 belonged to family Syrphidae *i.e.* *Eristalis arvorum*, *Eristalis himalayensis*, *Eristalis tenax*, *Eristalis cerealis*, *Syrphus sp.* and *Scaeva opimiuss*; 2 each to Muscidae *i.e.* *Musca domestica* and *Fannia domestica* and Calliphoridae *i.e.* *Calliphora vicina* and *Lucilia sp.* and one to Dolichopodidae *i.e.* *Dolichopus sp.* Of 6 species of Lepidoptera, 2 each belonged to family Pieridae *i.e.* *Pieris canidia* and *Pieris sp.* and Nymphalidae *i.e.* *Vanessa cance* and *Pyrameis indica* and one each to Noctuidae *i.e.* *Heliothis sp.* and Zyganidae *i.e.* *Zyganea sp.* Of 3 species of Coleoptera, 2 belonged to family Coccinellidae *i.e.* *Coccinella septumpunctata* and *Coccinella sp.* and one to Chrysomelidae *i.e.* *Altica sp.* (Table 1). Present results on pollinator diversity are in accordance with the earlier observations of Gautam *et al.* (1995) who also observed hymenopteran, dipteran and lepidopteran pollinators on pear crop in Kullu valley of Himachal Pradesh. Earlier, Hong *et al.* (1989) recorded 88 species of insect pollinators on pear, peach and apple crops in North Korea. In a similar study, Abrol (1993) observed various hymenopteran pollinators including honeybees, bumble bees and carpenter bees on pear crop in Jammu and Kashmir.

### **Cherry (*Prunus avium* L.)**

Cherry flowers were visited by 31 species of insects belonging to 5 orders and 13 families of class Insecta. Of these, 12 species belonged to Hymenoptera, 10 to Diptera,

6 to Lepidoptera, 2 to Hemiptera and 1 to Coleoptera. Of 12 species of Hymenoptera, 5 belonged to family Vespidae *i.e.* *Vespa mandarina*, *Vespa velutina*, *Vespa flaviceps*, *Polistes maculipennis* and *Polistes sp.*; 2 each to Bombidae *i.e.* *Bombus tunicatus* and *Bombus sp.* and Halictidae *i.e.* *Halictus dasygaster* and *Halictus sp.* and one to Xylocopidae *i.e.* *Xylocopa fenestrata*. Of 10 species of Diptera, 6 belonged to family Syrphidae *i.e.* *Eristalis tenax*, *Eristalis arvorum*, *Eristalis himalayensis*, *Metasyrphus sp.*, *Macrosyrphus sp.* and *Episyrphus sp.*; 3 to Muscidae *i.e.* *Musca domestica*, *Musca sp.* and *Fannia domestica* and one to Calliphoridae *i.e.* *Lucilia sp.* Of 6 species of Lepidoptera, 2 each belonged to family Pieridae *i.e.* *Pieris canidia* and *Pieris sp.*; Nymphalidae *i.e.* *Vanessa cance* and *Neptis sp.* and Noctuidae *i.e.* *Heliothis sp.* and *Plusia sp.* Order Hemiptera comprised two species *i.e.* *Nysius sp.* and *Adolenda typica* belonging to Cixiidae. Order Coleoptera comprised one species only *i.e.* *Coccinella septumpunctata* belonging to family Coccinellidae (Table1). Present results on cherry pollinators corroborate the early findings of Bhalla *et al.* (1983 b), who observed 10 insect species on stone fruit crops in Himachal Pradesh and most important among them were hymenopteran and dipteran pollinators.

### **Peach (*Prunus persica* Batsch)**

Pollinator diversity studies on peach crop showed that peach flowers were visited by 40 species of insects belonging to 5 orders and 24 families of class Insecta. Of these, 15 species belonged to Hymenoptera 12 to Diptera, 9 to Lepidoptera, 3 to Coleoptera and 1 to Hemiptera.

Of 15 species of Hymenoptera, 4 belonged to family Vespidae *i.e.* *Vespa auraria*, *Vespa magnifica*, *Polistes maculipennis* and *Polistes sp.*; 2 each to Apidae *i.e.* *Apis cerana* and *Apis mellifera*; Bombidae *i.e.* *Bombus tunicatus* and *Bombus sp.* and Halictidae *i.e.* *Halictus dasygaster* and *Halictus sp.*; one each to Xylocopidae *i.e.* *Xylocopa fenestrata*; Ceratinidae *i.e.* *Ceratina hieroglyphica*; Formicidae *i.e.* *Holocomyrmex sp.*; Tenthredinidae *i.e.* *Athalia sp.* and Ichneumonidae *i.e.* *Fileantha sp.*

TABLE 1: Diversity of insect species visiting temperate fruit crops with their taxonomic status

Order HYMENOPTERA	Order DIPTERA	Order LEPIDOPTERA	Order COLEOPTERA	Order HEMIPTERA	Order THYSANOPTERA
<b>Family APIDAE</b>	<b>Family SYRPHIDAE</b>	<b>Family PIERIDAE</b>	<b>Family COCCINELLIDAE</b>	<b>Family CIXIIDAE</b>	<b>Family THIRIPIDAE</b>
1. <i>Apis cerana</i>	25. <i>Eristalis tenax</i>	49. <i>Pieris canidia</i>	65. <i>Coccinella septempunctata</i>	68. <i>Nysius</i> sp.	70. <i>Thrips</i> sp.
2. <i>Apis mellifera</i>	26. <i>Eristalis himalayensis</i>	50. <i>Pieris</i> sp.	66. <i>Coccinella</i> sp.	69. <i>Adolenda typicatic</i>	
3. <i>Apis dorsata</i>	27. <i>Eristalis cerasidis</i>	51. <i>Deltias</i> sp.	<b>Family CHRYSOMELIDAE</b>		
<b>Family BOMBIDAE</b>	28. <i>E. angustimarginalis</i>	52. <i>Gonepteryx rhamni</i>	<b>Family NYMPHALIDAE</b>		
4. <i>Bombus terrestris</i>	29. <i>Eristalis arvorum</i>	<b>Family NYMPHALIDAE</b>	53. <i>Pyrameis indica</i>		
5. <i>B. haemorrhoidalis</i>	30. <i>Eristalis</i> sp.	54. <i>Vanessa cance</i>	54. <i>Vanessa cance</i>		
6. <i>Bombus</i> sp.	31. <i>Metasyrphus corollae</i>	55. <i>Vanessa</i> sp.	55. <i>Vanessa</i> sp.		
<b>Family VESPIDAE</b>	32. <i>Macrosyrphus</i> sp.	56. <i>Nephtis</i> sp.	56. <i>Nephtis</i> sp.		
7. <i>Vespa mandarina</i>	33. <i>Episyrphus balteatus</i>	<b>Family NOCTUIDAE</b>	<b>Family NOCTUIDAE</b>		
8. <i>Vespa velutina</i>	34. <i>Episyrphus</i> sp.	57. <i>Heliothis</i> sp.	57. <i>Heliothis</i> sp.		
9. <i>Vespa flaviceps</i>	35. <i>Scaveva opinus</i>	58. <i>Plusia</i> sp.	58. <i>Plusia</i> sp.		
10. <i>Vespa magnifica</i>	36. <i>Scaveva pyrastri</i>	59. <i>Agrotis flammatra</i>	59. <i>Agrotis flammatra</i>		
11. <i>Vespa auraria</i>	37. <i>Melanostoma</i> sp.	60. <i>Agrotis</i> sp.	60. <i>Agrotis</i> sp.		
12. <i>Vespa</i> sp.	38. <i>Syrphus</i> sp.	61. <i>Sphinx</i> moth	61. <i>Sphinx</i> moth		
13. <i>Polistes maculipennis</i>	<b>Family MUSCIDAE</b>	<b>Family LYCAENIDAE</b>	<b>Family LYCAENIDAE</b>		
14. <i>Polistes</i> sp.	39. <i>Musca domestica</i>	62. <i>Heodes</i> sp.	62. <i>Heodes</i> sp.		
<b>Family HALICTIDAE</b>	40. <i>Musca</i> sp.	63. <i>Heliothorus</i> sp.	63. <i>Heliothorus</i> sp.		
15. <i>Halictus dasygaster</i>	41. <i>Fannia domestica</i>				
16. <i>Halictus</i> sp.	42. <i>Orthetia</i> sp.				
<b>Family ANDRENDIDAE</b>					
17. <i>Andrena</i> sp.		<b>Family ZYGANIDAE</b>			
<b>Family XYLOCOPIDAE</b>		64. <i>Zyganea</i> sp.			
18. <i>Xylocopa fenestrata</i>	<b>Family CORDYLIURIDAE</b>				
<b>Family FORMICIDAE</b>	43. <i>Scathophaga stereoraria</i>				
19. <i>Camponotus</i> sp.	<b>Family CALLIPHORIDAE</b>				
20. <i>Holocorymbus</i> sp.	44. <i>Calliphora vicina</i>				
<b>Family CERETINIDAE</b>	45. <i>Lucilia</i> sp.				
21. <i>Ceratina hieroglyphica</i>	<b>Family SEPSIDAE</b>				
<b>Family</b>	46. <i>Sepsis</i> sp.				
<b>TENTHRIDINIDAE</b>	<b>Family ASILIDAE</b>				
22. <i>Athalia</i> sp.	47. <i>Promachus</i> sp.				
<b>Family</b>	<b>Family</b>				
<b>ICHNEUMONIDAE</b>	<b>DOLICHOPODIDAE</b>				
23. <i>Filicentha</i> sp.	48. <i>Dolichopus</i> sp.				
<b>Family SCOLIIDAE</b>					
24. <i>Elis thoracica</i>					

Of 12 species of Diptera, 4 belonged to family Syrphidae *i.e.* *Eristalis tenax*, *Eristalis cerealis*, *Scaeva opimius* and *Syrphus* sp.; 2 each to Muscidae *i.e.* *Musca domestica* and *Fannia domestica* and Calliphoridae *i.e.* *Calliphora vicina* and *Lucilia* sp. and one each to Cordyluridae *i.e.* *Scathophaga stereoraria*; Sepsidae *i.e.* *Sepsis* sp.; Asilidae *i.e.* *Promachus* sp. and Dolichopodidae *i.e.* *Dolichopus* sp. Of 9 species of Lepidoptera, 3 belonged to family Pieridae *i.e.* *Pieris canidia*, *Pieris* sp. and *Gonepteryx rhamni*; 2 each to Nymphalidae *i.e.* *Pyrameis indica* and *Vanessa cance* and Noctuidae *i.e.* *Heliothis* sp. and *Plusia* sp. and one each to Lycaenidae *i.e.* *Heliophorus* sp. and to Zyganidae *i.e.* *Zyganea* sp. Of 3 species of Coleoptera, 2 belonged to family Coccinellidae *i.e.* *Coccinella septumpunctata* and *Coccinella* sp. and one to Chrysomelidae *i.e.* *Altica* sp. Order Hemiptera comprised of only one species *i.e.* *Nysius* sp. belonging to family Cixiidae (Table 1). Present pollinator diversity studies on peach crop are in accordance with the earlier findings of Kumar (1995) who reported 33 species of insect pollinators on peach flowers, which belonged to 4 orders and 18 families of class Insecta. Of these, 12 species belonged to Hymenoptera, 12 to Diptera, 8 to Lepidoptera and 1 to Coleoptera.

#### **Plum (*Prunus domestica* L.)**

Pollination studies on stone fruit crops showed that plum flowers were visited by 19 species of insects belonging to 4 orders and 11 families of class Insecta. Of these, 8 species belonged to Hymenoptera, 5 to Diptera, 5 to Lepidoptera, and 1 to Coleoptera.

Of 8 of Hymenoptera, 2 each belonged to family Apidae *i.e.* *Apis cerana* and *Apis mellifera*; Bombidae *i.e.* *Bombus tunicatus* and *Bombus* sp.; Vespidae *i.e.* *Vespa auraria* and *Vespa* sp. and Halictidae *i.e.* *Halictus dasygaster* and *Halictus* sp. Of 5 species of Diptera, 3 belonged to family Syrphidae *i.e.* *Eristalis* sp., *Macrosyrphus* sp. and *Metasyrphus* sp. and 2 to Muscidae *i.e.* *Musca domestica* and *Musca* sp. Of 5 species of Lepidoptera, 2 belonged to family Pieridae *i.e.* *Pieris canidia* and *Pieris* sp. and one each to Nymphalidae *i.e.* *Vanessa* sp.; Noctuidae *i.e.* *Plusia* sp. and Lycaenidae *i.e.* *Heodes* sp. Order Coleoptera comprised of only one species *i.e.* *Coccinella septumpunctata* belonging to family Coccinellidae (Table 1). Present studies support the findings of some earlier investigators who have observed different types of insect pollinators visiting plum flowers including bumble bees (*Bombus* spp.) and solitary bees belonging to the families Andrenidae and Megachilidae (Hooper, 1936; Brittain, 1933; Menke, 1951; Sharma *et al.*, 2001). Mann and Singh (1983) also found *Apis dorsata*, *Apis mellifera* and *Apis florea* in good proportion on the plum crop at Ludhiana. Thakur (1988) observed 15 species of insect visitors on plum flowers in Himachal Pradesh. Rana (1989) recorded 20 species of insects visiting plum bloom under mid-hill conditions of Solan area.

#### **Almond (*Prunus amygdalus* Batsch)**

Results showed that almond flowers were visited by 30 species of insects belonging to 4 orders and 17 families of

class Insecta. Of these, 10 species belonged to Hymenoptera, 12 to Diptera, 5 to Lepidoptera and 3 to Coleoptera.

Of 10 species of Hymenoptera, 3 belonged to family Apidae *i.e.* *Apis cerana*, *Apis mellifera* and *Apis dorsata*; 2 each to Bombidae *i.e.* *Bombus tunicatus* and *Bombus* sp. and Vespidae *i.e.* *Vespa flaviceps* and *Polistes maculipennis* and one each to Halictidae *i.e.* *Halictus dasygaster*; Formicidae *i.e.* *Camponotus* sp. and Scoliididae *i.e.* *Elis thoracica*. Of 12 species of Diptera, 5 belonged to family Syrphidae *i.e.* *Eristalis tenax*, *Eristalis cerealis*, *Eristalis himalayensis*, *Scaeva opimius* and *Syrphus* sp.; 2 each to Muscidae *i.e.* *Musca domestica* and *Fannia domestica*; and to Calliphoridae *i.e.* *Calliphora vicina* and *Lucilia* sp. and one each to Cordyluridae *i.e.* *Scathophaga stereoraria*; Asilidae *i.e.* *Promachus* sp. and to Dolichopodidae *i.e.* *Dolichopus* sp. Of 5 species of Lepidoptera, 2 each belonged to family Pieridae *i.e.* *Pieris canidia* and *Gonepteryx rhamni* and Nymphalidae *i.e.* *Pyrameis indica* and *Vanessa cance*; and one belonged to Noctuidae *i.e.* Sphinx moth. Of 3 species of Coleoptera, two belonged to family Coccinellidae *i.e.* *Coccinella septumpunctata* and *Coccinella* sp. and one belonged to Chrysomelidae *i.e.* *Altica* sp. (Table 1). These results are in conformity with the earlier observations of Thakur (1988), who found *Apis cerana*, *Apis mellifera* and *Halictus alphenus* as the most abundant visitors an almond bloom at Solan. Abrol *et al.* (1987) also reported *Apis cerana* as the frequent visitor on almond flowers at Srinagar (J&K). Ricciardelli and Quaranta (1992) observed *Apis mellifera ligustica* and *Bombus terrestris* as the dominant pollinators of different almond cultivars in Umbria. Kumar (1995) also reported 30 species of pollinators on almond bloom in Shimla hills, which belonged to 5 orders and 17 families of class Insecta. Of these, 9 species belonged to Hymenoptera, 12 to Diptera, 5 to Lepidoptera, 3 to Coleoptera and 1 to Thysanoptera.

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