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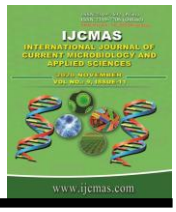

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A Preliminary Study on Insect Pollinators in Apple Crop in Different Geographical Zones of Himachal Pradesh

Preeti Kaundil* and Raj Kumar Thakur

Department of Entomology, Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan India

**Corresponding author*

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A B S T R A C T

Pollination is a critical mechanism that promotes the yield of many crops in our environment. The pollination process primarily includes banks of animal pollinators, of which the insect population forms a major part. Studies on diversity of various insect visitors to apple crop was made by collecting the flower visitors in different orchards located at Nauni (Solan), Mashobra (Shimla) and Seobagh (Kullu) in the year 2018-2019. Insect diversity studies showed that apple flowers were visited by 34 species of insects belonging to 5 orders and 11 families of class insect. Of these, 13 species belonged to Hymenoptera, 12 from Diptera, 5 from Lepidoptera, 3 from Coleoptera and 1 to order Thysanoptera. Among the insects sampled by different methods, *Apis mellifera*, *A. cerana* and *Episyrphus balteatus* were most frequent visitors.

Introduction

Pollination is an important service of the regulation, promotion and cultural environment (Chagnon *et al.*, 2015). It involves an integrated interaction framework that connects the vegetation of the earth, wildlife and human welfare (Kevan and Menzel, 2012). For the setting of fruits and seeds, many crops and wild plants need pollination. Pollination is the active and passive transfer within or between flowers of pollen (biologically speaking: transporting pollen from the output of anther to receiving the stigma of anthers).

Pollination offers an important ecosystem service that contributes to biodiversity conservation and ensures the survival of species of plant, including crops. One can thank a bee, butterfly, bat, bird or other pollinator for one out of every three bites eaten. Any loss of biodiversity is a matter of public concern, but the loss of pollinating insects can be particularly disturbing due to the potential impact on plant reproduction and, therefore, on food security. Many crops and populations of natural plants rely on pollination and often on the facilities provided by wild, unmanaged, pollinating communities (Free, 1993; Kluser and Peduzzi, 2007). Most

pollination-contributing insects fall under three orders, i.e. Lepidoptera, Hymenoptera and Diptera (Jadhav *et al.,* 2018; Bahir *et al.,* 2018).

In recent years, the apple has emerged in the Himalayan belt as the leading cash crop amongst temperate fruit crops. It alone accounts for 48 per cent of all fruit areas and 78 per cent of overall production of fruit. During this time, the area covered by apple production increased from 35,076 ha in 1975-76 to 99,564 ha in 2009- 10, showing an annual growth of 3.14 per cent (Singh *et al.,* 2012).

The yield of apples per hectare has decreased over the last few years, despite a rise in the area under apple cultivation. Therefore, modified strategies are needed and other potential inputs need to be looked for, such as maximum use of under used and environmentally friendly tools, such as bee pollination to increase state apple production (Verma and Jindal, 1997; Mattu *et al.,* 2012b; Mattu and Mattu, 2013; Mattu, 2014). Therefore, honey bees in apple orchards are also very effective pollinating insects and are the majority of pollinating insects (Free, 1993; Sharma *et al.,* 2000). In addition, only managed insects for orchard pollination are available.

Materials and Methods

Studies on diversity of various insect visitors to apple crop was made by collecting the flower visitors in different orchards located at Solan (Nauni), Shimla (Mashobra) and Kullu (Seobagh). These apple orchards had more than 200 trees belonging to Golden delicious, Red delicious, Royal delicious, Super chief, Redvelox, Redlum gala and Red Gold varieties. Almost equal numbers of working hours were spent in each orchard. Moreover, these collections were conducting during the year 2018-2019 from different geographical zones of Himachal Pradesh. For collection, the insect pollinators were collected by different sampling methods (Fluorescent pan trap, Sweeping method and Aerial netting method) (Figure 1).

Results and Discussion

The diversity of insect pollinators visiting apple flowers from different geographical zones of Himachal Pradesh during 2019 were collected by different sampling methods (Fluorescent pan trap, Sweeping method and Aerial netting method). A total number of 34 insects belonging to 5 orders and 11 families of class insecta. Of these, 13 species belonged to Hymenoptera, 12 from Diptera, 5 from Lepidoptera, 3 from Coleoptera and 1 to order Thysanoptera. Hymenopterans visitors belonged to four families namely Apidae, Halictidae, Vespidae and Ichneumonidae. Hymenopterans were represented by species like *Apis mellifera*, *Apis cerana*, *Apis dorsata*, *Bombus haemorrhoidalis*, *Ceratina smaragdina*, *Xylocopa amethystine*, *Xylocopa violacea*, *Halictus* sp., *Polistes* maculipennis, *Vespa auraria*, *Vespa* sp, *Xanthopimla* sp. Of the dipterans, species like *Episyrphus balteatus*, *Sphaerophoria Indiana*, *Eupeodes* sp., *Metasyrphus confrater*, *Ischiodon scutellaris*, *Eristalis tenax*, *Melanostoma*, *Sepsid fly*, *Chrysomya megacephala* and *Musca* sp. spread over families Syrphidae, Sepsidae, Calliphoridae and Muscidae. Moreover, 5 species of lepidopterans were spread over families like Pieridae and Nymphalidae. Order Coleoptera was represented by one family i.e. Coccinellidae. In addition, a single species of thrips belonging to order Thysanoptera was also recorded as pollinator of apple crop (Table 1). Among the insects sampled by different methods, *Apis mellifera*, *A. cerana* and *Episyrphus balteatus* were most frequent visitors (Figure 2).

Table.1 Diversity of insect pollinators visiting apple flowers with their taxonomic status

Order	Family	Scientific Name
Hymenoptera	Apidae	*Apis mellifera* Linnaeus
		Apis cerana Fabricius
		Apis dorsata Fabricius
		Bombus haemorrhoidalis Smith
		Ceratina smaragdina Smith
		Xylocopa amethystina (Fabricius)
		Xylocopa violacea
	Halictidae	*Halictus* sp.
	Vespidae	*Polistes maculipennis*
		Vespa auraria Smith
		Vespa sp. 1
		Vespa sp. 2
	Ichneumonidae	*Xanthopimla* sp.
Diptera	Syrphidae	*Episyrphus balteatus* (De geer)
		Sphaerophoria Indiana Bigot
		Eupeodes sp.
		Metasyrphus confrater (Wiedemann)
		Ischiodon scutellaris (Fabricius)
		Eristalis tenax (Linnaeus)
		Eristalis sp.1
		Eristalis sp.2
		Melanostoma
	Sepsidae	*Sepsid fly*
	Calliphoridae	*Chrysomya megacephala*
	Muscidae	*Musca* sp.
Lepidoptera	Pieridae	*Pieris candida*
		Pieris brassicae (Linnaeus)
		Vanessa cardui
		Vanessa cashmirensis
		Colias erate
Coleoptera	Coccinellidae	*Coccinella septumpunctata*
		Coccinella sp. 1
		Coccinella sp. 2
Thysanoptera	Thripidae	*Thrips* sp.

Fig.1 Use of fluorescent pan trap for passive sampling


Fluorescent coloured traps (Yellow and blue)


Insects caught in fluorescent trap

Fig.2 Important Hymenopteran and Dipteran insect visitors of apple flowers

Apis cerana F.

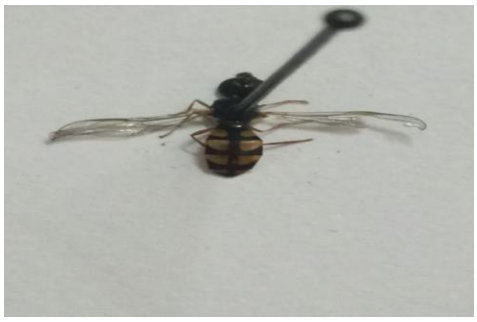
Apis mellifera L.

Bombus haemorrhoidalis

Xylocopa violacea

Eristalis tenax L.

Eupodia frequens



Melanostoma

Different investigators on different temperate fruit crops have reported different number of pollinators. For example, in Shimla hills, 44 species of insect pollinators were observed in Verma and Chauhan (1985), of which 16 belonged to Hymenoptera, 11 to Diptera, 9 to Lepidoptera, 7 to Coleoptera and 1 to Hemiptera on apple bloom. Hong *et al.*, (1989) found a total of 88 species of pollinators on apple, pear and peach flowers in similar survey in North Korea, while Kumar (1997) recorded that 49 insect species in the Himalayan belt visited apple flowers.

Similarly, Thapa (2006) observed the presence in Nepal of 50 species of insect pollinators on flowers from different crops and found that honeybees accounted for 80 per cent of the overall pollination of insects. Pollinator diversity studies by Mattu *et al.*, (2012a) and Raj *et al.*, (2012) have also shown that 46 species of insects belonging to 5 orders and 17 families of class insecta have been visited by apple flowers.

It is proposed on the basis of current studies that hymenopterans and dipterans were the most abundant insect pollinators in apple bloom. Such findings confirm the findings of kumar (1995).

In conclusion the studies clearly show that the role of pollinators in increasing the fruit production in apple flowers is significant. As the populations of wild honey bees often fluctuate at various locations and between the years, adding hive bees to fruit orchards will ensure increased fruit production in apple crops.

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