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DIVERSITY AND RELATIVE ABUNDANCE OF CITRUS POLLINATORS IN DISTRICT HARIPUR, PAKISTAN

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ABSTRACT:- As many as 3094 specimens of adult citrus pollinators collected from district Haripur represented four orders of insects i.e., Diptera with 16 species, Hymenoptera with 14 species, Lepidoptera with 3 species and Coleoptera with 2 species. The calculated values of relative abundance showed that *Musca domestica* is most abundant species in ecosystem followed by *Sarcophaga* sp. and *Apis mellifera*. All calculated values of diversity indices except Shannon-H does not show significant difference. Shannon's diversity shows that Naseem Town is most diverse locality then Nikrian B with relative values of 2.213 and 1.136.

Key Words: Citrus; Insect Pollinators; Species; Identification; Pakistan.

INTRODUCTION

Pollination is one of the most important mechanisms in the maintenance and conservation of biodiversity and life on earth. Two thirds of the world's 3000 species of agricultural crops require pollinators. Pollination by insects and other arthropods is a requirement for about 90% of flowering plants (Linder, 1998, Ollerton, 1999). Pollination is essential for the sexual reproduction of plants, required for the production of a wide range of crops including fruits, nuts and fibers and it increases yield of other crops such as coffee and oranges (Gordon and Davis, 2003; Klein et al., 2007). Worldwide economic value of the pollination service provided by insect pollinators, bees mainly was 153 billion dollars in 2005 for the main crops that feed the world (Blawat and Fingler, 1994). More than 80% of the total pollination activities are done by insects and bees (Robinson and Morse, 1989). Co-evolution of flowering plants and their pollinators started about 225 million years ago (Price, 1975). Both the abundance and diversity of insect pollinators documented as beneficial to the yield of numerous crops (Talavera et al., 2001; Kremen et al., 2002). It has been established from records that insects were potentially effective pollinators and their visits to flowers increased` the fruit production (Luce and Morris, 1928; Leppik, 1960). Among the several animals, insects particularly honey bees, dominate in providing pollination services to several plants (Meena, 2012). Thapa (2006) reported that over 50 species of insects visited flowers of 17 different species of selected crops during flowering periods. Asif et al. (2008) studied the insect pollinators of onion. Saeed et al. (2012) con-

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cluded that pollinator community of bitter gourd comprised 15 insect species belonging to 3 orders and 10 families, bees were the dominant floral visitors while moths and wasps were denoted as occasional and five major pollinators were tested for their single-visit efficacy, showing that *A. dorsata* was the most effective pollinator, along with *A. florea* and *Eristalinus laetus*. Conservation and enhancement of these pollinators may increase bitter gourd (*Momordica charantia* L.) production in Pakistan. Shahid et al. (2013) explored the pollinator fauna of Litchi resulting 23 species under 16 genera in 8 families of Orders Hymenoptera and Diptera from Haripur. In Pakistan, Sarwar et al. (2008 and 2012) studied effect of honey bee on fruit setting and yield of cucumber and Sajjad et al. (2012) studied spatial variation in pollinator communities and reproductive performance of *Prosopis julifora*.

Pakistan enjoys a well-known position among leading citrus producing countries of the world. Citrus is grown in Pakistan on 176400 ha with an annual production of 243800 tons (GoP, 2006). Orange, Tangerine, Kino, Musammi, Lime, Grapefruit, Lemon, etc. are produced in abundance in Pakistan. Khanpur in District Haripur, Pakistan is famous for its unique orange production. The Red orange and Succri are mostly grown varieties in Haripur District. Present study is under taken to evaluate diversity and relative abundance of insect pollinators in citrus orchards at Haripur.

MATERIALS AND METHOD

The study was conducted from March 13, 2013 to April 30, 2013. The adult pollinators were collected by using white, florescent blue and florescent yellow bowls traps. Seventy two pan traps, 24 each of florescent-blue, florescent-yellow and florescent- white placed at 5 m apart from each other. Bowls were placed in a line with alternate colors at open, visible and shiny place. Each pan trap was filled with water and a few grains of detergent (*surf*) in it to minimize the surface tension of water. Bowls were placed from 0900h to 1600h. At the end of sample period the liquid in pan traps was sieved to extract the insects and were washed in water 2-3 times. The collected insects were transferred to sealable killing jars with ethyl acetate. The collected specimen were pinned, labeled and preserved in collection boxes. Specimens were identified with relevant literature and deposited at National Insect Museum National Agricultural Research Centre, Islamabad.

RESULTS AND DISCUSSION

During the present study total of 3094 specimens were collected. Thirty five species in 25 genera belonging to 4 orders, 13 families and 17 subfamilies were identified. The orders include Diptera, Coleoptera, Lepidoptera and Hymenoptera (Table 1).

Order Diptera represented four families namely, Syrphidae, Muscidae, Sarcophagidae and Calliphoridae. Syrphidae is the much encountered family on citrus in the sampled area and 13 species were collected. The family is represented by three subfamilies including Syrphinae, Eristalinae and Chrysotoxinae. Family Muscidae was much abundant but represented by a single species. Sarcophagidae was also not

Table 1. Number of individuals of citrus pollinators in Haripur District

S. No	Species	No of specimens
1	*Musca domestica*	2023
2	*Sarcophaga* sp.	228
3	*Apis mellifera*	124
4	*0rthalia* sp.	110
5	*Episyrphus balteatus*	108
6	*Lasioglossum (Evylaeus)* sp.	96
7	*Apis cerana*	86
8	*Apis florae*	72
9	*Lucilia* sp.	61
10	*Osmia* sp.	48
11	*Apis dorsata*	20
12	*Ischiodon scutellaris*	18
13	*L. (Lasioglossum s. str.)* sp.	17
14	*Melanostoma orientale*	14
15	*Megandrena s.str.* sp.	12
16	*Eupeodes confrater*	9
17	*Scaevea pyrastri*	6
18	Vaspid Wasp	5
19	*Eristalis cerealis*	5
20	*Harmonia dimidiata*	4
21	*Coccinella septempunctata*	4
22	*Ceratina sexmaculata*	4
23	*Ceratina hieroglyphica*	4
24	*Ceratina binghami*	3
25	*Xylocopa fenstrata*	2
26	*Sphecodes* sp.	2
27	*Pieris brassicae*	1
28	*Lycaena phlaeas*	1
29	*Eupeodes pseudonitens*	1
30	*Eupeodes corollae*	1
31	*Eristalis tenax*	1
32	*Eristalis quinquelineatus*	1
33	*Chrysotoxum baphyrus*	1
34	*Betasyrpus issaci*	1
35	*Argyreus hyperbius*	1
Total		3094

represented well and only one i.e., *Sarcophaga* sp. belonging to Sarcophaginae was visiting the citrus flowers. Family Calliphoridae is not a frequent group on citrus and represented only by one species of genus *Lucilia*. Similarly Syrphidae were represented by *Ischiodon scutellaris* Fabricius, *Scaevea pyrastri* Linnaeus, *Betasyrpus issaci* Bhatia, *Melanostoma orientale* Wiedeman, *Episyrphus balteatus* De Geer, *Eupeodes* spp. *Eristalis cerealis* Fabricius, *Eristalis tenax* Linnaeus, *Eristalinus quinquelineatus* Fabricus and *Chrysotoxum baphyrus* Walk.

Order Hymenoptera is represented by five families; Andrenidae, Halictidae, Megachilidae, Apidae and Vespidae. Among all families of Hymenoptera, Apidae is most abundant with two subfamilies and eight species while family Halictidae resulted in only one subfamily including four species. Family Andrenidae, Megachilidae and Vespidae resulted with only one subfamily and one species each.

Subfamily Andreninae represented by only one species of genus *Megandrena* sp. Subfamily Helictinae contained four species. Subfamily Megachilinae was rare one with only one species. Subfamily Apinae was most abundant subfamily of order Hymenoptera as pollinator of citrus with seven species. Subfamilies Xylocopinae and Vespinae also recorded by only one species each. Species of order Hymenoptera are *Megandrena s.str*, *Cockrell, Sphecodes* sp. L. (*Lasioglossum s. str.*) sp., *Lasioglossum (Evylaeus)* sp. *Osmia Panzer s.str* sp. *Apis florea*, *Apis mellifera*, *Apis dorsata*, *Apis cerana*, *Ceratina hieroglyphica*, *Certaina sexmaculata, Certaina binghami, Xylocopa fenstrata* and wasp species.

Order Coleoptera is identified with only one family Coccinellidae subfamily Coccinellinae species are

Coccinella septempunctata and *Harmonia dimidiata* Fabricius. In this order both species showed same abundance.

Order Lepidoptera is represented by three families; Nymphalidae, Lyceanidae and Pieridae. All three subfamilies of this order are resulted by only one species and same abundance from all orchards of citrus in sampling localities. Species include *Argyreus hyperbius* Johanssen, *Lycaena phlaeas* Linnaeus and *Pieris brassicae* Linnaeus.

Data revealed insect pollinators abundance i.e., *Musca domestica*, *Episyrphus balteatus* and *Lasioglossum evyleaus* were the principle insect pollinators of citrus (Table 1). Subfamily Syrphinae showed highest value of relative percentage abundance. Among all four orders of insect in citrus orchards, Diptera was most abundant pollinator. Clement et al. (2007) concluded that *Musca domestica* L. (Diptera: Muscidae), and *Calliphora vicina* Robineau-Desvoidy (Diptera: Calliphoridae) were pollinators on *Allium ampeloprasum* L. (Alliaceae). The calculated values of Simpson's index (D) at all localities ranged from 0.291 to 0.3954. The values of Shannon diversity ranged from 2.213 to 1.136 of all localities which mean that there is a slight difference of species diversity.

Shannon equitability values lies between 0.1499 and 0.2713, showing that all species are equally distributed among all localities.

Menhinick index ranged in all localities from 0.5109 to 0.7618 which means there is no significant difference in all localities as value of this index depends upon the size of sample, as large sampled locality contain more taxa.

Nakamura index results showed that all values were less than one, which did not show any difference among all localities as this index increases towards one.

Localities selected for sampling were 3 orchards with red blood variety of citrus and two with mixed cultivation. Among mixed cultivation one orchard of red blood was mixed with grape fruit and 2nd was mixed with Mandarin and Kino Oranges. Grapefruit mixed orchard showed more diverse insect pollinator community as compare to Kino, Mandarin mixed orchard and red blood variety containing orchards. Red blood variety at Sikandarpur resulted more evenness as compared to other localities which is due to presence of other flowering fruits present around the orchard such as loquat, peach and litchi which finished flowering few days before starting of citrus flowering. Margalef, Nakamura diversity indices and Equitability did not show any difference and have almost same values in all localities (Figure 1).

Simpson, Menhinick, Nakamura, Evenness and Equitability indices have no significant difference and almost values of all localities are approximately same. Shannon diversity indices showed that water availability when needed, provided better diversity as compare to localities where water was available for 24 h.

All calculated values of diversity indices did not show big difference. The present study is the first study of this type in the Khyber Pakhtunkhwa. Therefore, it is very difficult to say whether any species is supported by the enriched flora or any species

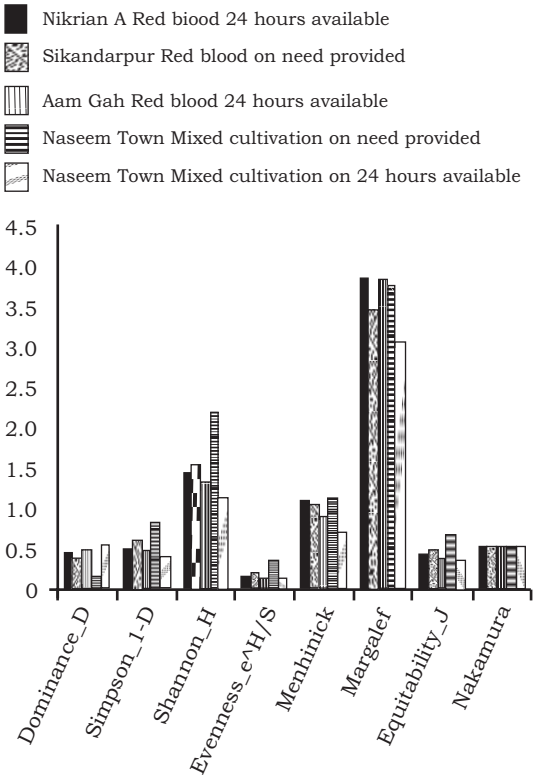

Figure 1. Calculated values of diversity indices in all localities of District Haripur

threatened to extinction.

It is concluded that *Musca domestica*, *Episyrphus balteatus* and *Lasioglossum (Evyleaus)* sp. were the principle insect pollinators of citrus. Subfamily Syrphinae showed highest value of relative percentage abundance. Among all four orders of insect in citrus orchards, Diptera was most abundant pollinator.

Diversity indices i.e, Shannon's diversity index with equitability component, Margalef's index, Nakamura's index and Menhinick's index were used. All calculated values of diversity from entire localities did not show significant difference in total number of individuals.

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AUTHORSHIP AND CONTRIBUTION DECLARATION

S.No	Author Name	Contribution to the paper
1.	Mr. Abdul Haq	Did SPSS analysis, Conclusion, Data collection, Results and Discussion, Introduction, References
2.	Mr. Anjum Shehzad	Conceived the idea, Wrote abstract, Methodology, Technical input at every step, Overall management of the article
3.	Mr. Muhammad Ilyas	Technical input at every step
4.	Dr. Muhammad Ishaque Mastoi	Wrote abstract, Methodology, Technical input at every step
5.	Mr. Abdul Rauf Bhatti	Technical input at every step
6.	Dr. Mian Inayat ullah	Technical input at every step

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