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Insect pollinators and their relative abundance on pea (*Pisum sativum*) at Peshawar

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Abstract

The present study was conducted in New Developmental Farm (N.D.F), The University of Agriculture Peshawar during 2014-2015 to find the species of insect pollinators and their abundance on pea at Peshawar. Insects that visited as pollinator were observed on each second day at morning (9:00 am - 12:00 pm) and evening (3:00 pm- 5:30 pm) of the flowering season i.e. 16/2/2015 to 28/3/2015. Total twelve species of insect pollinators were observed out of which seven belongs to order Diptera (*Scaeva pyrastris*, *Eupeodus bucculatus*, *Eristalis tenax*, *Episyrphus balteatus*, *Ischidan scutellaris*, *Sphaerophora scripta* and *Calliphora vomitoria*), two species (*Apis florea* and *Apis mellifera*) belong to order Hymenoptera and two to order Lepidoptera i.e. *Pieris brassicae* and *Zizina otis* while only one specie belong to order Coleoptera (*Coccinella septempunctata*). *Episyrphus balteatus* was reported most abundantly with 35.22% followed by *Apis mellifera* with 15.94%. *Eristalis tenax* and *Pieris brassicae* had lowest density as pollinator with 2.77% and 2.94% respectively throughout the flowering season. Percent population of *Episyrphus balteatus*, *Ischidan scutellaris* and *Calliphora vomitoria* was more during evening than morning. Population of pollinators reached maximum during the mid-till the end of March, 2015.

Keywords: Pea, Insect pollinators, Diptera, Flowering season

1. Introduction

The word Pea has been derived from a Latin word "Pisum" which itself is made from a Greek word "Pison" [1]. Its scientific name is *Pisum sativum* and family Fabaceae [2]. Pea is grown in most part of the world. After soybean and common beans it is the world's third most significant legume grain [3].

Pea as a crop is grown for human consumption due to its qualities of higher proteins content i.e. 20-27% on average, balanced amino acids composition, good taste, easy digestion and its good production in suitable pea cultivated areas and thus grown and used abundantly. Pea seeds are processed to make cereals, flour, green peas. Pea fixes nitrogen, therefore it is considered very beneficial for treatment of land and also good forerunner to next crop. It can also be used as manure, food source for livestock and as a source of formation of hay for animals [4] [5]. Studies have shown a very positive impact of Pea on human health. It has been found that green peas are very much useful in lowering blood sugar and increasing insulin level [6]. One pound of green peas contains 36.1 g carbohydrates, 13.7g protein, 8g fat, 54 mg ascorbic acid, 45 mg calcium and 29 mg phosphorus [7]. In India fresh peas are used in several cuisines such as curried potatoes with peas (aloo matar) or cheese with peas (matar paneer). Frozen peas can also be used as a substituent to fresh peas in cuisines. In U.K dry peas are separated and used in making of pudding. Pea soup is liked in most part of the world including countries in Northern and Central Europe, Russia, Iraq and India [8].

In Pakistan the life span of pea plant is three months. Average pea ranges from 0.1 grams to 0.36 grams in weight [2]. Commonly, in Pakistan it is cultivated in winters and summers of Northern areas and its contribution in pulses trade is about 40% [9]. In Pakistan during 2011-2012 total production of pea was about 105 thousand metric ton, which was obtained from 15800 hectare of cultivated land [10]. During the year 2013-2014 total area under cultivation of pea crop in Khber Puktunkhwa was 1865 hectare and production was 13058 tons with an average yield of about 7002 kg per hectare [11].

Pollinators are biological agents which carry pollens from anthers to stigma. Male gametes which develop from pollens fertilize female gametes in ovule. The most famous and trust worthy pollinators belong to different species of bees. It plays a backbone role in fruiting of

crops and has a great importance in a good pollinating management during blossom of a crop. Some parts of their body are adapted particularly for pollens transmission. Normally, body of bees are furred and therefore, can carry pollens; both these characteristics help them in sticking pollens to their body. In most of bees types, the hind legs or lower abdomen for e.g. in Megachilid bees have special pollen carrying structures. These structures are made up of thick, plumose setae. There are other pollinators such as Blue bottle flies, Bumble bees, leaf cutter bees and Orchard mason bees which are cultured and sold as pollinators. Lepidopteron insects help to pollinate plants to great extent [12].

Keeping in view the above facts the present study was conducted to know the insect pollinators and their relative abundance during morning and evening hours on pea plant in Peshawar valley.

2. Material and methods

The present study was conducted at New Developmental Farm (NDF) of The University of Agriculture Peshawar to determine the relative abundance of insect pollinators at morning and evening on pea plants *Pisum sativum*, the effect of plant population and pesticide on the role of pollinators and its impact on pea yield during the year 2015. Size of the experimental field was 36m x24m.

2.1 Data collection

The data were collected after every two days at two time interval from 9-12 am and 3:00-5:30 pm from the start of flowering stage up to the crop maturity. Pea plants in the plot was given a time of 60 minutes in each observation, during which the specie and number of insect pollinators visited were noted. The relative abundance of insect pollinators was determined by using the formula:

$$\text{Relative abundance of species} = \frac{\text{Number of individuals visit flowers} \times 100}{\text{Total number of pollinators}}$$

2.2 Collecting of Insect Pollinators Visiting Pea Flowers

At the flowers bloom stage diverse species of insect pollinators was collected for further study. Hand net was used for the collection of insect pollinators. The collected specimens were properly labelled, identified up to species level and was

preserved. The identified specimens were submitted to the research laboratory of the department of Entomology.

For identification of insect species, belonging to family Syrphidae [13], Calliphoridae [14], Apidae [15], Pieridae, Lycaenidae [16] and Coccinellidae [17] different keys were used.

3. Results and discussion

3.1 List of Insect pollinators of Pea plant at Peshawar Valley 2015

The table 1 below shows various insect pollinators of pea plants in Peshawar valley. The table indicates that out of twelve, seven species of pollinator belong to order Diptera in which six species belong to family Syrphidae i.e. *Scaeva pyrastris* (Pied hover fly), *Eupeodus bucculatus*, *Eristalis tenax* (European hover fly), *Episyrphus balteatus* (Marmalade hover fly), *Ischidan scutellaris* (Common hover fly) and *Sphaerophora scripta* (Long hoverfly) while only one to family Calliphoridae i.e. males of *Calliphora vomitoria* (Blue bottle fly). The table further shows two species of Hymenopteran pollinators belonging to family Apidae i.e. *Apis florea* and *Apis mellifera* with common names of Dwarf honeybee and European honeybee respectively, two Lepidopteran pollinators i.e. *Pieris brassicae* (Cabbage butterfly) and *Zizina Otis* (Blue butterfly) of the families of Pieridae and Lycaenidae respectively and one Coleopteran pollinator i.e. *Coccinella septempunctata* (Lady bird beetle) of the family Coccinellidae.

Mukherjee *et al.* [14] reported honey bees, butterflies and lady bugs that were serving as pollinator. Li *et al.*, [15] studied at two different locations and observed more than 46 and 25 species of insect pollinators of the pigeon pea. Breez *et al.*, [16] in United Kingdom and Pole *et al.*, [17] from their study revealed that *Apis mellifera* is the most outstanding pollinator. Rashmi *et al.*, [18] found thirty species of insect pollinators of pigeon pea: out of these thirty species twenty one species were Hymenopteran, four lepidopteran and one Coleopteran while the rest belonged to other orders. Sajjad *et al.*, [19] observed *Episyrphus balteatus* and *Apis mellifera* most abundantly as pollinators. Sabir *et al.*, [20] investigated that honeybees especially the *Apis mellifera* played a key role in pollination. Ali and Ali [21] found *Apis florea*, contributing to pollination. Soomro *et al.*, [22] observed number of bees and dipterian insects as a major pollinator.

Table 1: List of Insect Pollinators of Pea at Peshawar Valley 2015.

S.no.	Technical Name	Common Name	Family	Order
1	<i>Scaeva pyrastris</i>	Pied hover fly	Syrphidae	Diptera
2	<i>Eupeodus bucculatus</i>	-	Syrphidae	Diptera
3	<i>Eristalis tenax</i>	European hover fly	Syrphidae	Diptera
4	<i>Episyrphus balteatus</i>	Marmalade hover fly	Syrphidae	Diptera
5	<i>Ischidan scutellaris</i>	Common hover fly	Syrphidae	Diptera
6	<i>Sphaerophora scripta</i>	Long hover fly	Syrphidae	Diptera
7	<i>Calliphora vomitoria</i>	Blue bottle fly	Calliphoridae	Diptera
8	<i>Apis florea</i>	Dwarf honey bee	Apidae	Hymenoptera
9	<i>Apis mellifera</i>	European honey bee	Apidae	Hymenoptera
10	<i>Pieris brassicae</i>	Cabbage butterfly	Pieridae	Lepidoptera
11	<i>Zizina otis</i>	Blue butterfly	Lycaenidae	Lepidoptera
12	<i>Coccinella septempunctata</i>	Lady bird beetle	Coccinellidae	Coleoptera

3.2 Average Population Dynamics of Insect Pollinators on Pea Plants

Average of the population of each Insect pollinator is taken separately, that were reported in pea plants at two time intervals i.e. 9:00 am – 12:30 pm and 3:00 pm – 5:30 pm from 3rd week of February to the 4th week of March (16/2/ 2015 to 28/3/2015) and shown in the figures below.

In figures below from 1 to 12, W1 means time interval between 16 to 20/2/15, W2: 22 to 26/2/15, W3: 28/2/15 to 6/3/15, W4: 11 to 17/3/15 and W5: 21 to 28/3/15.

i. *Scaeva pyrastris*

The Figure 1 show population trend of *Scaeva pyrastris*. In W1 both in morning and evening the average population of pollinator is 1.33. In W2 the average population is increased to 2.33 during morning and reached to 2.66 during evening of the same week. In W3, the values become 1.66 and 1.33 in morning and evening respectively. During W4, in morning the average of population is 2.33 and reached to its maximum during morning of W5 i.e. 3. During W4 in evening the value became 1.66, but decreased greatly to its lowest point of 0.33 during W5 in evening. Generally population of *Scaeva pyrastris* is greater in morning than evening.

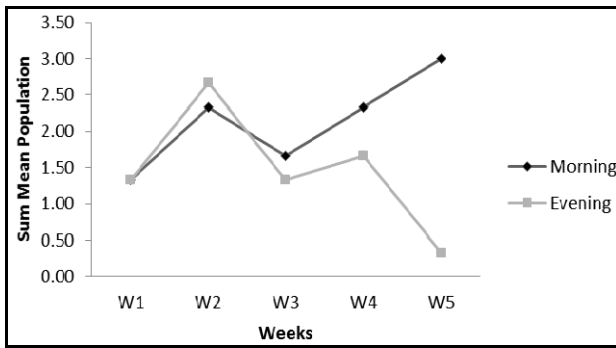


Fig 1: Mean population dynamics of *Scaeva pyrastris* on Pea plant.

ii. *Eupeodes bucculatus*

During W1, the average population of *Eupeodes bucculatus* in morning and evening is 3.33 and 0.66 respectively, while in W2 the values raised to 5 and 3.33 in morning and evening respectively. In W3, W4 and W5 during morning the average population of pollinator is 4, 4.66 and 5 respectively, while in evening of the same weeks i.e. W3, W4 and W5, the average population is 4, 2.66 and 5.66 respectively. Collectively more *Eupeodes bucculatus* are recorded in morning than that reported in evening (Fig. 2)

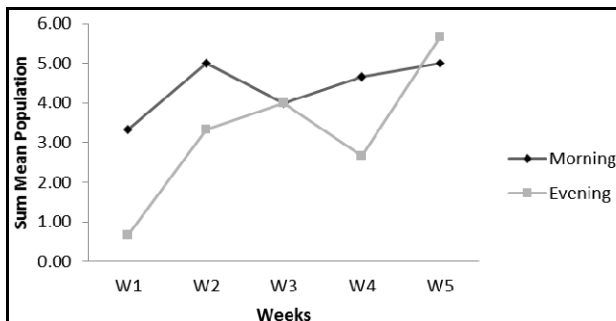


Fig 2: Mean population dynamics of *Eupeodes bucculatus* on Pea plant.

iii. *Eristalis tenax*

The Figure 3 indicates mean population dynamics of *Eristalis tenax*. The figure shows average population of 0.33 both during morning and evening in W1. In W2 the values of population is 3 and 2.33 in morning and evening respectively, while in W3 the average population is similar i.e. 2 during morning and evening. In W4 and W5 the average population during morning is 2 and 2.66 respectively, while during evenings of same weeks the values of population is 1.66 and 0.66 respectively. The Figure 3 clearly shows that overall population at morning is greater than population at evening.

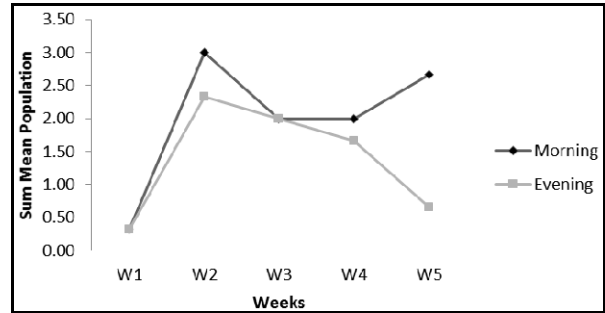


Fig 3: Mean population dynamics of *Eristalis tenax* on Pea plant.

iv. *Episyrphus balteatus*

From the Figure 4 we infer that *Episyrphus balteatus* has average population of 16.66 and 9.33 in W1 during morning and evening respectively, while in W2 the values of average population is 14.66 and 16.33 in morning and evening respectively. In W3, W4 and W5 the average population of *Episyrphus balteatus* is 10, 32.66 and 34.33 respectively during morning. On the other hand during evening of W3, W4 and W5 the average values of population is 15.33, 27.66 and 38.66 respectively. Overall Population of the pollinators recorded during morning is more than that reported during evening from W1 to W5.

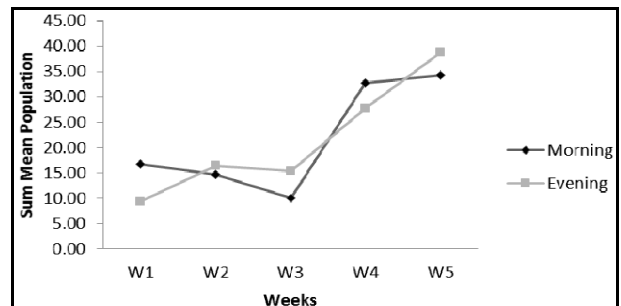


Fig 4: Mean population dynamics of *Episyrphus balteatus* on Pea plant.

v. *Ischiolan scutellaris*

The Figure 5 indicates least average population of 0.33 and 1.33 in morning and evening during W1 of *Ischiolan scutellaris*. In W2 average population of the pollinator is 5.33 and 3 during morning and evening respectively. The figure further shows average of 3 and 3.66 of the population in W3 during morning and evening respectively. In W4 and W5 mean population during morning is 7.33 and 4.33 respectively while in evening it is 5.33 and 11.33 respectively. Collectively population of *Ischiolan scutellaris* is higher during evening than that observed in morning.

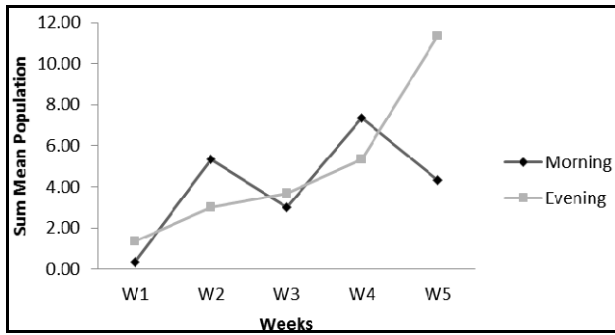


Fig 5: Mean population dynamics of *Ischiodon scutellaris* on Pea plant.

vi. Sphaerophoria scripta

The Figure 6 shows mean population trend of *Sphaerophoria scripta* that served as a pollinator during the experimental weeks i.e. week 3rd of February to week 4th of March. During W1, W2, W3, W4 and W5 average population of pollinator in morning is 0.33, 6, 5.33, 2.66 and 6.33 respectively, while in evening during W2, W3 and W4 the average population is same i.e. 2.66. Mean population of the *Sphaerophoria scripta* is 1 and 3 during evening in W1 and W5 respectively. Generally, population of *Sphaerophoria scripta*, recorded in morning is higher than that of evening.

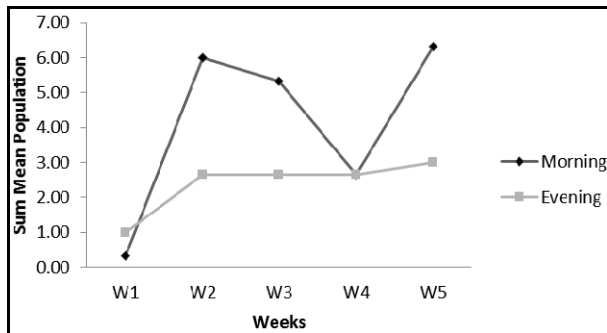


Fig 6: Mean population dynamics of *Sphaerophoria scripta* on Pea plant.

vii. Calliphora vomitoria

The Figure 7 indicates that average population of *Calliphora vomitoria* is 0 and 0.66 in W1 during morning and evening respectively. In W2 the values of mean population become 2.66 and 3.33 during morning and evening respectively. The mean population is similar with a value of 2.33 in morning, both during W3 and W4, while in evening the values are 0.66 and 1.33 during W3 and W4 respectively. In W5 the average population is 2.66 and 2.33 during morning and evening respectively. Overall population in morning is higher than that reported in evening.

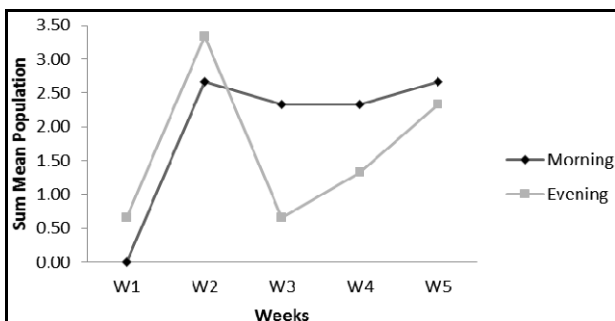


Fig 7: Mean population dynamics of *Calliphora vomitoria* on Pea plant.

viii. Apis florea

From the Figure 8 we infer that *Apis florea* has an average of 2.33, 6.33, 2, 1.66 and 3.66 of the population during morning in W1, W2, W3, W4 and W5 respectively. In evening during W1 the average population is 1.66, while in W2 and W3 during evening the figure shows similar values of average population i.e. 2.66. During evening in W4 and W5 the mean population of *Apis floreae* is 1.33 and 1 respectively. The figure further shows that population in morning during most of the observation weeks is greater than evening.

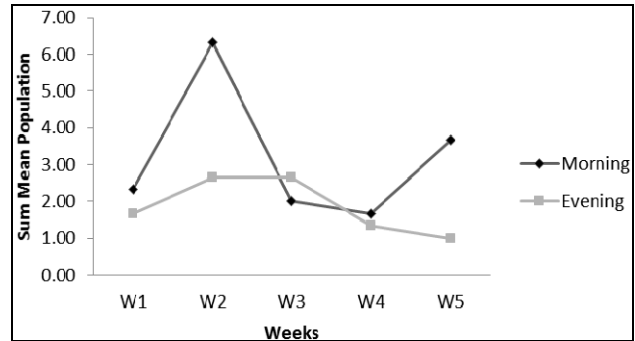


Fig 8: Mean population dynamics of *Apis florea* on Pea plant.

ix. Apis mellifera

Figure 9 shows mean population dynamics of *Apis mellifera* from 3rd week of February to 4th week of March. Figure indicates mean population of 10 and 11.33 in morning during W1 and W2 respectively, while in evening during these weeks the average population is 8.33 and 12.66 respectively. During W3 both in morning and evening the average of population is showing same value of 9.66. In W4 during morning and evening the values of average population are 11.66 and 9.33 respectively, while in W5 during morning and evening the values are 14.66 and 0.33 respectively. Population recorded of *Apis mellifera* during the experimental weeks is more in morning than that reported in evening.

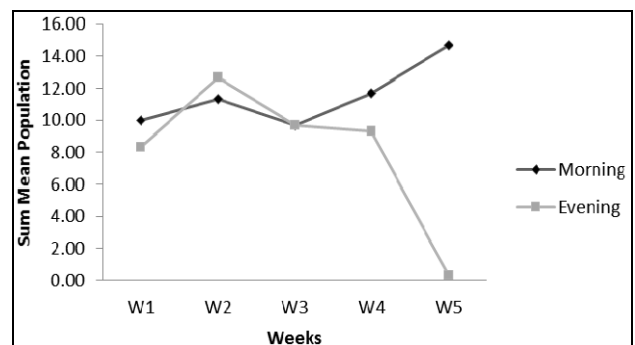


Fig 9: Mean population dynamics of *Apis mellifera* on Pea plant.

x. Pieris brassicae

The figure shows mean population of *Pieris brassicae*. The figure infers that in W1, W2 and W3 the average values of population during morning is 1.33, 4.66 and 2 respectively, while W4 and W5 are showing same values (2.33) in morning. In evening during W1, W3 and W5 mean population of *Pieris brassicae* is 1, 1.66 and 1.33 respectively. W2 and W4 in figure are indicating similar average values of population i.e. 0.66 in evening. Comparing with the evening population of the

pollinator is high in morning during observation weeks (Figure 10).

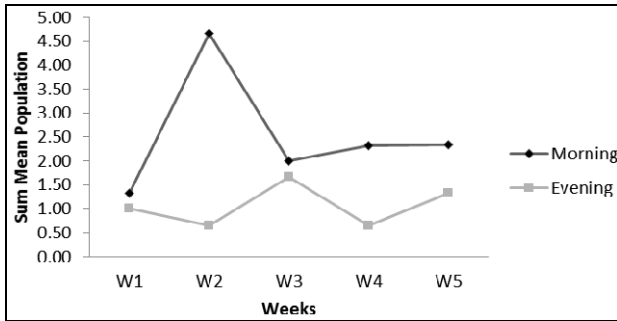


Fig 10: Mean population dynamics of *Pieris brassicae* on Pea plant.

xi. *Zizina otis*

The Figure 11 clearly indicates that in morning during W1, W2, W3, W4 and W5 the average population of *Zizina otis* is 0, 4.66, 2.66, 3.33 and 5 respectively. In evening during W1 and W5 the average values of population are 0.66 and 2.33 respectively, while W2, W3 and W4 are showing same values of mean population that is 1.33. Generally the population of *Zizina otis* is higher in morning than evening.

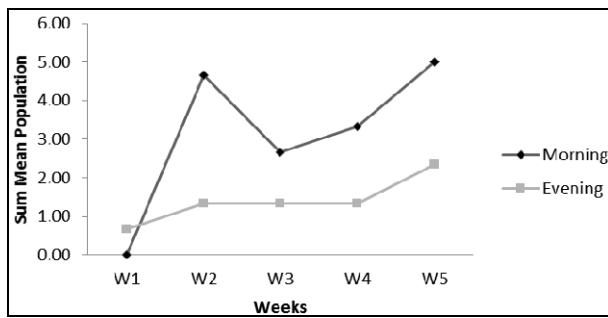


Fig 11: Mean population dynamics of *Zizina otis* on Pea plant.

xii. *Coccinella septempunctata*

The figure shows that in morning and evening during W1, mean population of *Coccinella septempunctata* is 8 and 7.33 respectively. Average population of the pollinator is 10 and 3.66 in morning and evening respectively during W2. In W3, W4 and W5 during morning average population of *Coccinella septempunctata* is 8.66, 3.66 and 8.33 respectively, while in evening the average population is 2.66, 4.66 and 6.66 respectively (Figure 12). Collectively population density of *Coccinella septempunctata* is more during morning than evening through the five weeks of observation.

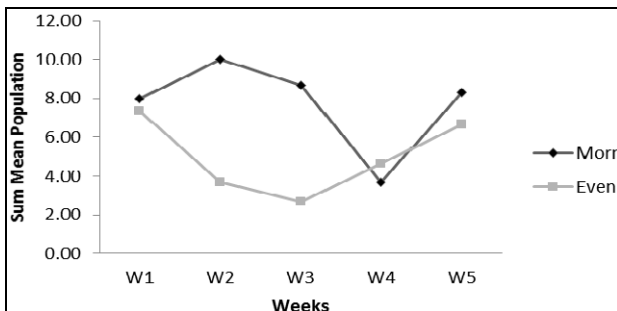


Fig 12: Mean population dynamics of *Coccinella septempunctata* on Pea plant

Relative abundance (%) of different species of Insect Pollinators at morning (9:00 am-12:00 pm) and evening (3:00 pm-5:30 pm) on Pea plants in Peshawar Valley

The figure 13 shows percent relative abundance of insect pollinators in morning and evening separately in bars. Figure indicates that in morning population percentage of *Scaeva pyrastris* was 3.12, while in the evening the percentage was 2.72, lesser as compared with the morning. From the figure 13 we further infer that population of *Eupeodus bucculatus* was more (6.43%) during morning comparing with evening (6.05%). According to the figure *Eristalis tenax* was observed more i.e. 2.92% during 9:00 am - 12:00 pm than during 3:00 pm- 5:30 pm which was 2.59%. The relative abundance of *Episyrphus balteatus* and *Ischiodan scutellaris* when calculated among the total insect pollinators in the evening was found out to be 39.75% and 9.14% respectively where as the percentage of the same pollinators was recorded to be 31.65 and 5.94 amongst the pollinators observed in the morning (Figure 13). The figure further says that population of *Sphaerophora scripta* among insect pollinators recorded during morning was greater i.e. 6.04% than that in evening which was 4.44%, while in case of *Calliphora vomitoria* during evening the relative abundance among other pollinator species was more with 3.09% as compared with the morning which was 2.92%. Relative abundance of *Apis florea*, *Apis mellifera* and *Pieris brassicae* among the insect pollinators reported between time intervals of 9:00 am - 12:00 pm was higher i.e. 4.67%, 16.74% and 3.74% respectively than its abundance between 3:00 pm- 5:30 pm i.e. 3.46%, 14.93% and 1.97% respectively. The figure 13 indicates relative abundance of *Zizina otis* and *Coccinella septempunctata* which was more in morning (4.58% and 11.30% respectively) than in evening (2.59% and 9.25% respectively).

Our results are at par with the conclusions made by Douka and Fohouo (2013) [23] from their research. They found that a single honey bee of specie *Apis mellifera* in a minute visits 27.98 flowers. Results of Ali and Ali (1989) [21] show concurrence with our findings, as they noticed *Apis florea* with a very little prevalence. Sajjad *et al.*, (2008) [19], noticed 14 *Episyrphus balteatus* that visited 25 plants in 20 minutes, i.e. they found it most frequently among all other observed insect pollinators. They also found that density of all visiting pollinators were higher in morning i.e. 10:00 am – 12: 00 pm than evening. Both of their findings have shown resemblance to our study.

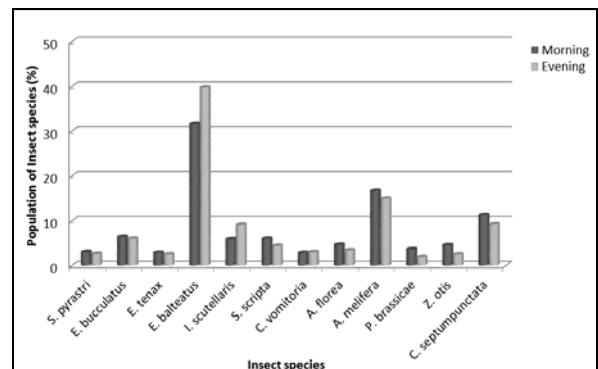


Fig 13: Relative abundance (%) of different species of Insect Pollinators at morning (9:00 am-12:00 pm) and evening (3:00 pm-5:30 pm) on Pea plants in Peshawar Valley.

4. Conclusion and recommendations

From our research work we concluded that maximum insect pollinators belong to family Syrphidae of order Diptera. *Episyrphus balteatus* and *Apis mellifera* were the major pollinators of Pea in Peshawar. Most of the insect pollinator species visited abundantly in morning as compared to evening. Most of the pollinators achieved their highest density from mid till the end of March. Farmers are advised not to apply insecticide from mid till the end of the March on pea plant i.e. during peak blossoming stage as it would adversely affect the pollinators. Farmers should concern honeybee keepers in order to place bee colonies in their field, so that pollination is enhanced. All those practices should be adopted that could make the environment favourable for Syrphid flies and Honeybees as these are the most prevalent pollinators of pea plant in Peshawar.

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