Insect Pollinators on Canola Crops Peshawar

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ABSTRACT
This study was conducted with the aim of studying the detailed activity of the community of pollinators, that are interacting within the canola crop during, 2019-2020, at the newly development farm (NDF). This research was able to report a diverse community of insect pollinators, with 15 species, from a variety of orders and families. One aspect of the study, which were are happy to report is the species composition of said pollinators. A highlight was the order Diptera, that had 8 species. Also fairly representative was family Syrphidae, which is known for its pollination services, which was also well-represented with 7 species. The family Apidae, which is part of the order Hymenoptera, had 4 species. To complete the picture of insects interacting in the canola, there were two more species of Lepidoptera and one of Coleoptera. Of significance were the activity patterns of the all these pollinators. Of interest is the European (honey) bees, mainly species of Apis mellifera, remained consistently active throughout the day, as the main pollinator for the canola. Similarly, European hoverflies, represented by Eristalis tenax, showed an impressive consistency in activity, further supporting their role in contributing to pollination. Hoverflies, the most abundant members of the dipteran family Syrphidae, served as important participants in the pollination role. To a lesser degree, other common hover flies such as the Common hover fly (Ischiodon scutellaris), and long hover fly (Sphaerophora scripta), showed considerable biomass during falls from the group. Their consistent presence and activity show their importance in the reproductive success, and ultimately, seed production for canola plants. In addition, while the individual role of specific pollinator species is important, the research also emphasized the importance of conserving biodiversity within canola fields. As it illustrated to us the importance of benefits in biodiversity when presenting diverse and functional floral resources, the conclusion of the study reflected an urgency to enact steps to conserve, and effectively manage, pollinator species. Conservation and management practices are important in stabilizing the sustainability of canola populations and farm production longevity using sustainable cropping production methods.
Keywords: Insect pollinators, population dynamics, diversity, canola crops, Peshawar

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Received: 28-01-2025
Revised: 20-02-2025
Accepted:30-03-2025

INTRODUCTION
Canola is a type of winter oilseed crop plant known identified botanically as Brassica napus and is a member of the family Brassicaceae. Canola passed through the breeding of rapeseed and was formerly called Cruciferae. Canola is comprised of 23-35% protein (most canola is 28% protein) and possesses between 40 -44% oil content and is also ranked second in overall cooking oil usage after soybean (Kandil and Gad, 2012; USDA, 2016). In Pakistan, canola is a minor oilseed crop. Canola has potential to be propagated on infertile,marginal land with poor soil quality moisture and is also tolerant of salt and is therefore drought resistant (Flanders and Abdu, 1985; Shannon and Grieve 1999). The family Brassicaseae consists of 3,000 species with 333 genera (Warwick and Shehbaz, 2006.In our nation,rapeseed and mustard are are key oil-producing crops

(Khan et al 2004). Canola is cultivated in a range of agro climate conditions, is able to withstand during drought and stress conditions. In Europe, both Brassica napus and Brassica campestris are tilled, while predominantly in Canada flourishes during spring time. In China, Brassica napus is primarily cultivated during spring time while in India and the subcontent, Brassica junica is leading and in Ethiopia Brassica carinata predominates (Prakash and, Hinata 1980).
High levels of protein and free amino acids have been linked to sensitivity to canola aphid whereas ascorbic acids and glucosinolates act as deterrents to pest populations (Malik, 1981, Labana et al, 1983). Insect pest infestation in Pakistan is close to 80 percent with extreme infestations destroying crops and rendering crops infeasible for future germination (Rustamani et al, 1988). There were 243,000 hectors of total canola area in Pakistan with a overall output of 231,000 tons. The canola area in Khayber Pakhtunkhwa was 17,000 hectare with a production of 8000 tons and an average yield of 493kg/h (Anon, 2013-2104). Historically,rapeseed oil served as a lubricant because of its high glucosinolate and euric acid content (Charlton et al, 1975).The use of canola for lamp oil has roots in ancient times,with 13th century European farming documented. The family Brassicaceae is classified into four species, B. napus, B. carinata, B. junicea and B. compestris.
The total canola manufacturing value in 24.61million metric tons is found in from 14 million hectares growing area which provides 12% to the globally consumeable use. (Colton and Sykes 1992 canola crops suffer many insect pests, primary and secondary; Flea beetles, head caterpillar, butterflies, diamond back moth etc., and also from hamipterans like thrips, jassid, whitefly, and aphids. The yield in the crop is significantly compromised with the infestation of these insects, and can affect overall yield. For market value control, formers applied toxic pesticides effective against insects and pests that are detrimental to humans,animals and ecological balance. (AVRCD, 2011). Ladybugs are a type of a very familiar pest population predator, 75 species from Pakistan (Rafi et al., 2005). Ladybird mainly feed on other insects, their larvae and the adult stage feed on aphids. Ladybird beetles are also prevalent, especially on plant life that has heightened aphid numbers (Mohyuddin, 1981).
Chrysoperla carnea (Stephen) is the predatory insect and is a enemy of susceptible egg and small egg, larval stage lepidopterous pests, aphids, jassids and mealy bugs. It has a relative advantage over the egg parasitoid and has the ability to prey on both the immature stage of pests and has a Multiple host species(Khan et al., 2005). According to Kannan (1999) the natural enemies noted that were preying on aphids were chrysopids, coccinellids and syrphids. Among these antagonists chrysopids served as a primary biological control agents.Messina and Sorenson (2001) also noted the one lacewing presence diminished on several plants and gave an 84% effectiveness on the aphids. The utmost leading biological control agents are Aphidius colemani, Aphidius ervi, Diaertilla rapae and Aphidius morticaiae

MATERIALS AND METHODS

Study Area

A research research conducted at New Developmental Farm (NDF) of The University of Agriculture, Peshawar, in 2019, was exploring the efficiency of chemical and botanical extracts for canola aphids control.

Insect Collection

All the collected insects were recorded and transported to the Department of Entomology for identification. Specimens were identified using the collection material available at the laboratory and using entomological keys.

Collecting Pollinators:

All the insect pollinators were collected by using hand nets at the flowering stage for further study. The collected specimens were labelled and preserved in the Department of Entomology. The identification was carried out using the literature available in the department and the labelled specimens were submitted.

Data Collection:

The pollinator data were recorded in two time intervals: 10am to 12pm and 3pm to 5pm, starting with the flower initiation and finishing on the crop maturity. The observation was monitoring for five intervening minutes for different pollinators. The relative abundance was computed at :

$$\text{RA of species:} \quad \frac{\text{Number of individual visiting flowers} \quad *100}{\text{Total numbers of pollinators}}$$

Data Analysis
Data recorded from sowing to harvest were analysed on STATTISTIC-8.1. The means were separated at α=5% significance level after the application of which the Least Significant Difference method.

RESULTS

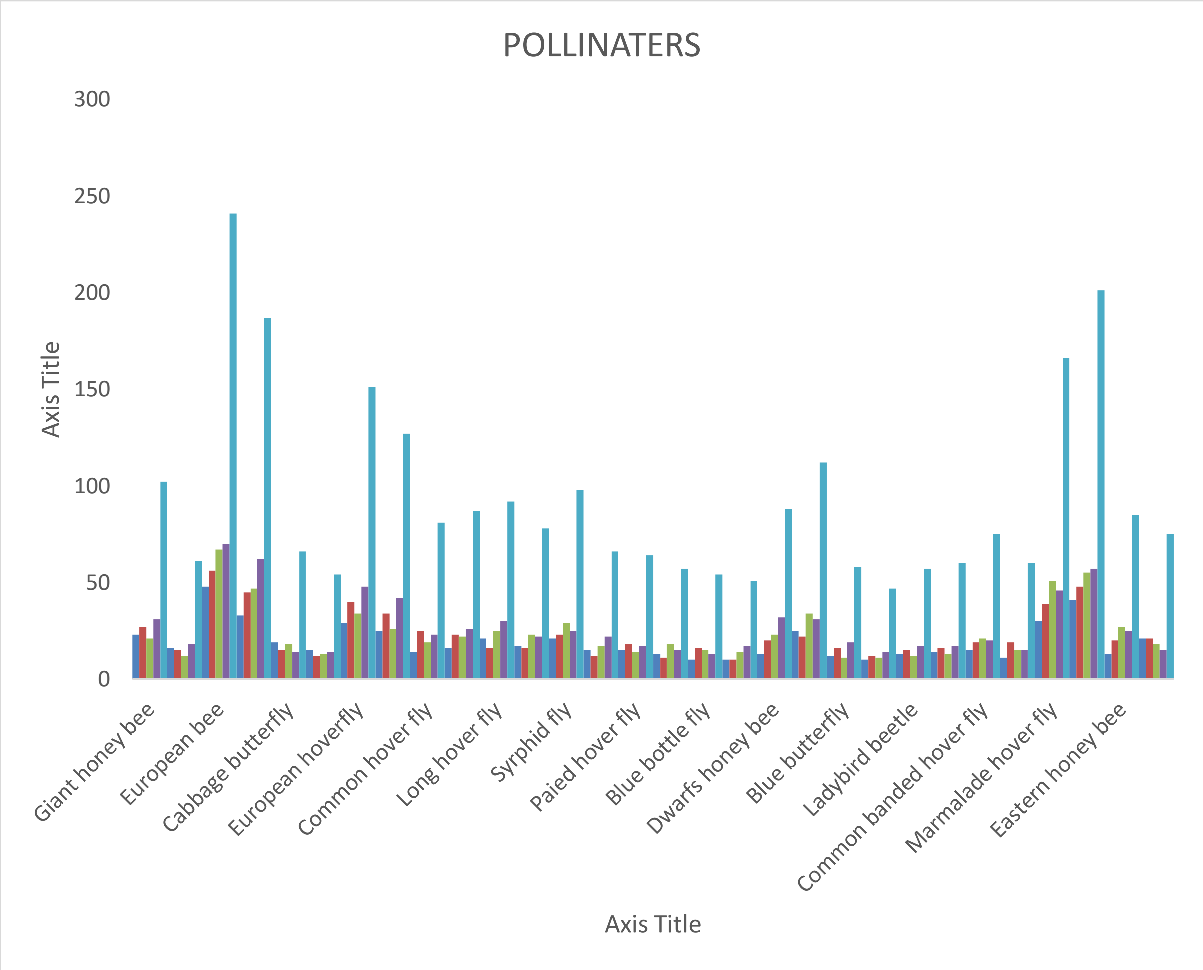
Between the period of 2019-2020, a detailed study was completed at the Newly Developmental Farm (NDF) of the University of Agriculture, Peshawar, to understand the population dynamics of canola pollinators. The study describes the various agents that aided pollination for canola plants at AUP Peshawar, and is summarized in the table below. Overall 15 different pollinator species were identified in the study, revealing an abundant diversity of pollinators. The total of 15 species includes eight species from the order Diptera, indicating that this group of insects is important to canola pollination. Seven of these eight Dipteran pollinators were from the family Syrphidae, suggesting this family is also important to canola pollination ecology. The Dipteran species were Scaeva pyrastri, Eupeodes eristalis, Episyrphus balteatus, Ischiodon scutellaris, Sphaerophora scripta, and Syrphus ribesii unlike the one species from the family Calliphoridae included Calliphora vomotoria. The other four species were from the family Apidae in the order Hymenoptera which were identified as important to canola pollination.
The species we identified include Apis florea, Apis cerana, Apis mellifera and Apis dorsata, showing the very clear and major role of bees in the pollination network with respect to canola. We also identified two butterflies from the order Lepidoptera; Pieris brassicae from the family Pieridae and Zizina otis from the family Lycaenidae, which indicates the prescribing role of butterflies in pollination of canola. We also recorded Coccinella septempunctata from the order Coleoptera in the family Coccinellidae. Although lady beetles and other species of this family were not included amongst the major or common pollinators, the fact that lady beetle species were recorded adds to the pollination complexity and suggests some opportunity for pollination from even more diverse groups of insect taxa.

Order	Family	Common Name	Technical Name
Diptera	Syrphidae	Common banded hover fly	*Syrphus reibessi*
Lepidoptera	Lycaenidae	Blue butterfly	*Zizina otis*
Diptera	Syrphidae	European hover fly	*Eupeodes bucculatus*
Diptera	Syrphidae	Paied hover fly	*Scaeva pyrastri*
Lepidoptera	Pieridae	Cabbage butterfly	*Pieris brassica*
Diptera	Syrphidae	European hover fly	*Eristalis tenax*
Hymenoptera	Apidae	Giant honeybee	*Ischiodan scutellaris*
Hymenoptera	Apidae	Dwarfs honey bee	*Apis florea*
Diptera	Calliphoridae	Blue bottle fly	*Calliphora vomitoria*
Coleoptera	Coccinellidae	Ladybird beetle	*Coccinella septempunctata*
Diptera	Syrphidae	Marmalade hover fly	*Episyrphus balteatus*
Diptera	Syrphidae	Long hover fly	*Sphaerophora scripta*
Diptera	Syrphidae	Common hover fly	*Ischiodan scutellaris*
Diptera	Syrphidae	Syrphid fly	*Eupeodes bucculatus*
Hymenoptera	Apidae	Eastern honeybee	*Apis cerana*

For bees, flies, beetles, and butterflies, we have grouped species mentioned in this list according to their orders and families. This is helpful for understanding taxonomy and where they fit into the ecology of the system. A variety of researchers have conducted studies highlighting the importance of insect pollinators with respect to particular crops, which is further evidence of the wide variety of insect species that contribute to insect pollination, and that changes in pollinator density relies on these studies in crop yield and fruit quality. Naeem et al. (2016): looked at pea crops and about 12 species of insect pollinators contributed to pollination of pea crops. This shows the range of insect species that can contribute to the act of pollinating pea plants. Karanja et al. (2013): studying bees and their role as pollination agents in coffee and berry crops, indicates that the bees are involved in influencing the mass cultivation of crops with high standards.Douka and Fohou (2013): although they studied honeybee performance in foraging behavior while they were outstanding pollinators during the flowering season, note how crucial they are for the pollination activity during the blossoming season. Bodlah and Waqar (2013): in their work looking at plants in the families of vegetables, they concluded that hymenopterous and dipterous insects were important in pollination of vegetables. Once again they indicated that these groups of insects played a role in the process of vegetable crop pollination. Aumkin and Velkova (2013): examined the diversity of insect families that act as agents of pollination on mustard crops, highlighting the wide variety of insects that contribute to the pollination of mustard plants. Mukherji et al. (2013): Investigated the roles of butterflies, honeybees and ladybugs as pollination agents noting the significance of these insects pollination services for a variety of crops. Pole et al. (2012): investigated the role of Apis mellifera (honeybees) as the primary pollen transfer agent, documenting the direct relationship between bee pollination activity and crop yield. Abrol (2012): found that bees are important species in an ecological system and contribute to biodiversity and ecological stability. Breez et al. (2011): stated the role of honeybees as main pollination agents, especially within agriculture, is important due to the amount of economic value pollination services provide. Mudassar et al. (2011): reported that Apis dorsata, Apis florea, Halictus species are the principal pollination agents and lead to increased canola farming. Ahmad et al. (2003) found that the rarity of visits from pollination agents, especially from pollinators did not lead to significant seed yields due to the importance of effective visitation rates to ensure successful crop production.

Population Densities of insect Pollinators of canola at Morning and Evening in NDF Peshawar

Common Name	*Scientific Name*	Time Interval	W1	W2	W3	W4	Total
Common banded hover fly	*Syrphus ribessi*	MORNING-10:00-12:00	15	19	21	20	75
Blue butterfly	*Zizina otis*	MORNING-10:00-12:00	12	16	11	19	58
European hover fly	*Eristalis tenax*	MORNING-10:00-12:00	29	40	34	48	151
Paied hover fly	*Scaeva pyrastri*	MORNING-10:00-12:00	15	18	14	17	64
Cabbage butterfly	*Pieris brassicae*	MORNING-10:00-12:00	19	15	18	14	66
European hover fly	*Eupeodes bucculatus*	MORNING-10:00-12:00	21	23	29	25	98
Common hover fly	*Ischiodan scutellaris*	MORNING-10:00-12:00	14	25	19	23	81
Long hover fly	*Sphaerophora scripta*	MORNING-10:00-12:00	21	16	25	30	92
Syrphid fly	*Eupeodes bucculatus*	MORNING-10:00-12:00	21	23	29	25	98
Giant honeybee	*Apis dorseta*	MORNING-10:00-12:00	23	27	21	31	102
European bee	*Apis mellifera*	MORNING-10:00-12:00	48	56	67	70	241
Blue butterfly	*Zizina otis*	EVENING-03:00-05:00	33	45	47	62	187
European hover fly	*Eupeodes bucculatus*	EVENING-03:00-05:00	15	12	13	14	54
Paied hover fly	*Scaeva pyrastri*	EVENING-03:00-05:00	25	34	26	42	127
Cabbage butterfly	*Pieris brassica*	EVENING-03:00-05:00	16	23	22	26	87
European hover fly	*Eristalis tenax*	EVENING-03:00-05:00	17	16	23	22	78
Giant honeybee	*Ischiodan scutellaris*	EVENING-03:00-05:00	15	12	17	22	66
Dwarfs honeybee	*Apis florea*	EVENING-03:00-05:00	13	11	18	15	57
Blue bottle fly	*Calliphora vomitoria*	EVENING-03:00-05:00	10	10	14	17	51
Ladybird beetle	*Coccinella septempunctata*	EVENING-03:00-05:00	25	22	34	31	112
Marmalade hover fly	*Episyrphus balteatus*	EVENING-03:00-05:00	10	12	11	14	47



DISCUSSION

The data presented here shows how active different pollinator species were, during specific morning (10:00-12:00) and evening (03:00-05:00) times. In total, here is a discussion of the findings:

The Giant Honeybee was moderately active in the morning and evening. There were 102 observations during the morning periods and 61 observations during the evening periods. In fact, it is likely that the Giant Honeybee may be an important pollinator in the canola fields, it occurred often enough throughout the period to suggest the Giant honeybee could play a large role in pollination.

The European bee was very active with 241 early morning survey and 187 observations in the sundown. The European bee is one of the most common pollinators and their consistent presence in the canola fields supports an important role in canola pollination.

Cabbage butterfly activity was lower compared to bees and hoverflies. In the morning, there were 66 observations, and in the evening, there were 54 observations. Although not as abundant as bees, their presence suggests they could be a beneficial contributor to canola pollination.

The European hoverfly showed significant activity during the pollination hours. In the morning, there were 151 observations, and in the evening, there were 127 observations. Hoverflies are good pollinators, with the high observation counts, it appears that hoverflies could be an important pollinator to canola fields.

The Common hover fly was quite similar with the relatively constant activity levels at 81 observations in the morning and 87 observations in the sundown. The hover flies are known to visit flowers for nectar and where they are present would suggest they are present for canola pollination. The Long hover fly was observed at a moderate level with 92 dawn observation and 78 observations in the sundown. Even though their numbers were not as high as some of the species, they would indicate their role in pollination with respect to canola. The Syrphid flight was similar to the Long hover fly, while they were also observed at a moderate level of activity, 98 dawn assessment compared to 66 observations in the sundown. The Syrphid flies visit flowers for both nectar and pollen, indicating their potential role in canola pollination. The Paied hover fly had relatively low activity with 64 dawn assessment and 57 assesments in the sundown; it was still present for its demonstrating its role as a pollinator. The Blue bottle fly was also present at a relatively low level of 54 dawn assesments and 51 sundown assesments. The Dwarfs honeybee was observed at a moderate level of 88 dawn assesments and 112 sundown assesmrents.

The Blue butterfly had lower activity levels as compared to bees and hoverflies, with 58 dawn assesments and 47 sundown assesments. The Ladybird beetle had moderate activity levels with 57 dawn assesments and 60 sundown assesments. The Common Banded Hover Fly had moderate activity levels with 75 dawn assesments and 60 sundown assesments. The Marmalade hover fly showed high levels of activity with 166 observations in the morning and 201 sundown assesments. The Eastern honeybee had moderate activity levels with 85 dawn assesments and 75 sundown assesments.

The observations suggest variation in activity levels for the different pollinator species at different times of the day. In general, bees are more active for both the morning and evening time periods, but hoverflies also play a significant role in canola pollination. Future research studies could focus on digging deeper into the behaviours and preferences of these pollinators to enhance pollination strategies in the canola field.

CONCLUSIONS AND RECOMMENDATION

Conclusions

1. Data demonstrates variability in the amount of activity of diverse pollinators types in the dawn and dusk, which is important to understand in relation to canola flower fertilization. Large bee species,honeybee and the European bee, were showing an active presence of bees all day, which further emphasizes the role of bees as effective pollinators. Hoverflies, including the European hoverfly and the Marmalade hover fly, also had an active presence when pooled as a group, emphasizing their importance when considering the pollinating ecosystem of canola fields.
2. While the existence of other pollinators such as the garden butterflies may not be as large of population, it does highlight an important potential factor in pollination of canola. As well, ladybird beetles and common banded hover flies showed more steady activity, which would also confirm their involvement in the pollination process

Recommendations

1. Additional research on the behavior and preferences of the different types of pollinators on canola fields is required to better understand their patterns of flower visitation and foraging behaviors.
2. Conservation strategies should be implemented to conserve and restore the habitat of pollinators. Conservation actions must include preserving and providing diverse floral resources as well as not using pesticides that are harmful to pollinators.
3. Adaptive management and holistic Pest Management approaches are necessary for sustainable pest control ,while also managing the pollinamtor populations.
4. Farmers and agribusinesses need to recognize that pollinators are a valuable resource for crop producers and they should be pollinator protection initiatives.
5. By following these measures we can support thriving pollinator populations as well as, increase the production and sustainability of canola.

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