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Assemblages of Insect Pollinators in BARI Sarisha-17 (*Brassica rapa* L.) Cultivation Fields at the University of Rajshahi, Bangladesh

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The provision of pollination services by pollinators is threatened by declines in their abundance and diversity. The reduction in pollinator populations may result in a decline in plant species diversity. Research on insect pollinators is a significant topic of discussion among researchers worldwide, primarily due to population declines attributed to various stressors, including climate change and

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the scarcity of floral resources. This study investigates the variety and quantity of insect pollinators in BARI Sarisha-17 (*Brassica rapa* L.) Cultivation Fields at the University of Rajshahi are crucial to the success of agro-ecosystems. From November 2024 to February 2025, a field investigation was conducted to explore the diversity of insect pollinators. A total of 382 individuals belonging to 33 species of 17 families and 4 insect orders viz., Hymenoptera (6), Diptera (16), Lepidoptera (10), and Odonata (1) recorded in the mustard field. Dipterans were predominant (45.52%) and it was followed by Hymenoptera (42.67%), Lepidoptera (10.48%), and Odonata (0.79%). The diversity indexes were as follows: H' = 3.82, Evenness (E) = 0.8708, and Simpson Index = 0.9413. The significant variety and uniform distribution of insect pollinators in BARI Sarisha-17 fields underscore their essential function in facilitating pollination and improving crop yield. These results highlight the need to preserve pollinator habitats in agricultural settings to guarantee sustained crop production and ecosystem vitality. The findings highlight the ecological importance of pollinators in magnifying crop productivity through effective pollination services. Preserving such agroecosystems is essential for maintaining biodiversity and supporting sustainable agriculture and food security in the region.

Keywords: Ecosystem; insect pollinators; pollination; crop yield; Brassica rapa.

1. INTRODUCTION

Intensive agriculture is one of the key drivers of global–pollinator decline. More ecologically sustainable cropping methods are urgently needed to preserve pollinators and to maintain future crop yields. Despite of undeniable support to agroecosystem biodiversity in general, these actions are independent from farming practices and lack crop specificity (Singh & Pramod, 2024; Dey et al., 2025). This approach oversimplifies the role of functional diversity for crop production and ignores the potential of insect-pollinated crop applications, such as intercropping, which similarly integrate additional floral resources and habitat connectivity into agricultural production (Järvinen et al., 2022; Dylewski et al., 2024). Pollination is a biological process and specifically the first step in a plant's reproductive cycle. The process involves the transfer of pollen grains from the anthers of a flower to the stigma of the same species (Khan et al*.,* 2024). Crops of family Brassicaceae are very attractive for insect pollinators for a good source of pollens and nectar (Bashir et al., 2018). Globally 87.5% of flowering plants (Ollerton et al*.,* 2011) and 35% of the eaten crops (Protim et al., 2023) depend on animal pollination. Insect pollinators and flowering plants have a reciprocal relationship (Deeksha et al*.,* 2022) and are also key components of global food security (Kumar et al., 2024). Almost 75% of crop species depend on insect pollination (Protim et al*.,* 2023). Pollination by insects not only increases crop yield but also improves the physiochemical properties of fruits (Shakeel et al*.,* 2019). Insect-pollinated crops have a higher market value, making them economically important to intensive cropping systems, where industrial-scale agriculture is crucial for the national economy (Protim et al*.,* 2023).

Mustard (*Brassica* sp*.)* exhibits self-incompatibility, preventing its flowers from utilizing their pollen because the pollen is heavier and sticky, which is unable to be easily wind-borne (Protim et al*.,* 2023). *Brassica* species need biological agents, such as several insect groups, for the transport of pollen from male to female flowers (Protim et al*.,* 2023). Honeybees are considered the most significant insect pollinators for Brassica crops (Kumar et al., 2024). Other insects, including butterflies, flies, and wasps, also forage on Brassica flowers; however, their impact on yield enhancement is minimal (Devkota et al., 2021).

The provision of pollination services by pollinators is threatened by declines in their abundance and diversity. The reduction in pollinator populations may result in a decline in plant species diversity (Shakeel et al., 2019). The impact of pollinator scarcity on crop yield requires precise evaluation to assess the significance of pollinator decline resulting from various environmental stresses. The diversity and abundance of pollinators are negatively affected by anthropogenic disturbances or activities such as the destruction and fragmentation of habitats, the spread of pests and pathogens, invasion by non-native species, agricultural intensification, and genetically modified organisms (Shakeel et al*.,* 2019, Devkota et al., 2021, Protim et al*.,* 2023, Kumar et al., 2024).

Research on insect pollinators is a significant topic of discussion among researchers worldwide, primarily due to population declines attributed to various stressors, including climate change and the scarcity of floral resources. Though there are several studies have been conducted about the diversity of insect pollinators on various crops in Bangladesh, little study is available on insect pollinators in Mustard crops of agroecosystems in the Rajshahi region. Under these circumstances, the present study was conducted to identify insect pollinators, their relative abundance, and diversity indices in the mustard crops.

2. MATERIALS AND METHODS

2.1 Experimental Location

The experiment was conducted at the model research agrofarm of the University of Rajshahi, from November 2024 to February 2025. The experimental field was located at 24.37º N latitude and 88.65º E longitude. We selected three mustard fields with four-meter square areas with a completely randomized design.

2.2 Data Collection

The seeds of BARI Sarisha-17 (*Brassica rapa*) were sown in the field in November 2024. The scan/visual sampling method evaluated the diversity and frequency of flower-visiting insect pollinators linked to the blooms of the mustard species. Data were recorded weekly, with collections occurring in the morning from 10:00 to 12:00 PM and in the afternoon from 2:00 to 4:00 PM. For collecting the insects, the net sweeping method was used which has successfully been used by various workers (Shakeel and Mian Inayatullah 2015; Deeksha et al*.* 2022). The collected insects were placed into bottles with cotton soaked in ethyl acetate. All specimens were transported to the laboratory for additional analysis.

2.3 Statistical Analysis

Statistical analysis was done with Microsoft Excel 2013 and biodiversity indices were calculated following standard

(i) Shannon- Wiener equation (1949):

$$H'(S) = -\sum_{i=1}^{s} pi * \ln pi$$

Where pi = fraction of entire population made up of species; S = total number of species; i = proportion of species

(ii) Evenness Index (Hill, 1973):

$$E = H/ \ln S$$

Where, S = total number of species; H = Index of species;

(iii) Margalef's Index (Margalef,1970):

$$d= (S-1)/ \ln N$$

Where, S = the total number of species; N = the total number of individuals in the sample

(iv) Simpson Dominance Index (1949):

$$D=1-\Sigma n(n-1)/\Sigma N(N-1)$$

(v) Relative Abundance (%):

$$R = Isi/ \sum Nsi*100$$

Where, Isi = Total Number of individual spp; ∑ Nsi = Total Number of species population.

3. RESULTS AND DISCUSSION

During the research time, the experimental field was watched and insect pollinators visiting the mustard crop were gathered. The pollinator insects of mustard sp. and agriculture ecosystems included 382 individuals belonging to 33 species of 17 families and 4 insect orders viz., Hymenoptera (6), Diptera (16), Lepidoptera (10), and Odonata (1) (Table 1). Kamel et al*.* (2015) identified 21 species of insect pollinators across 14 families within four orders that visited the flowers of canola, *B. napus* whereas Devi et al*.* (2017) recorded 88 insect species from nine orders and 31 families associated with *Brassica juncea*. The Hymenopteran pollinators comprising of 6 species belonging to the Apidae family. Among the species, *Apis mellifera* was the most dominant which is consistent with Kunjwal et al*.,* (2014) and Shakeel and Mian Inayatullah (2015). In case of Dipterans comprises 17 species belonging to 10 families namely Muscidae, Tipulidae, Chironomidae, Sepedonidae, Calliphoridae, Syrphidae, Braconidae, Odontomyiidae, Stratiomyidae where Devi et al*.* (2017) found 16 species belonging to 4 families. The family Syrphidae was the most prevalent and represented by six species *viz*., *Eristalinus taeniops, E. arvorum, Toxomerus politus, Baccha elongate, Syritta flaviventris.* The Lepidopteran visitors comprise 10 species belonging to 5 families namely Erebidae, Nymphalidae, Crambidae, Pieridae, and Lycaenidae. Monappa and Sekarappa (2024) found 6 families and 30 species under Lepidopterans. The family Nymphalidae was preeminent and represented by *Junonia lemonias*, *J. almanac*, *J. atlites*, *and Ypthima ceylonica*. The Odonata was the least diversified order visiting mustard flowers which is in line with the result of (Monappa and Sekarappa, 2024);

Table 1. Species assemblage and relative abundance of pollinators at BARI Sarisha-17 (*Brassica rapa* L.) cultivation fields at the university of Rajshahi

Order	Family	Common name	Scientific name	Number of individuals	Relative Abundance
Hymenoptera	Apidae	Giant honey bee	*Apis dorsata*	27	7.07
		Western honey bee	*A. mellifera*	57	14.92
		Asian honey bee	*A. cerana*	38	9.95
		Cuckoo bee	*Thyrenus nitidulus*	15	3.93
		Carpenter bee	*Xylocopa sp*	13	3.40
		Small Carpenter bee	*Ceratina sp*	13	3.40
Diptera	Muscidae	House fly	*Musca domestica*	28	7.33
	Tipulidae	Crane fly	*Tipula paludosa*	16	4.19
	Chironomidae	Midge fly	*Chironomus plumosus*	12	3.14
	Sepedonidae	Marsh fly	*Sepedon spinipes*	10	2.62
	Calliphoridae	Green bottle fly	*Lucilia sericata*	16	4.18
	Syrphidae	Band-eyed drone fly	*Eristalinus taeniops*	23	6.02
		Hover fly	*E. arvorum*	3	0.79
		Hoverfly	*Toxomerus politus*	15	3.39
		Flower fly	*Baccha elongata*	4	1.05
		Yellow-belied hover fly	*Syritta flaviventris*	3	0.79
	Braconidae	Peg-legged compost fly	*Psyttalia fletcheri*	5	1.30
	Odontomyiidae	Wood gnats	*Odontomiya cincta*	13	3.40
		Common green colonel	*Odontomiya angulata*	5	1.30
	Stratiomyidae	Black soldier fly	*Hermetia illucens*	7	1.83
		Soldier fly	*Oplodontha viridula*	4	1.05
		Soldier fly	*Allograpta obliqua*	12	3.14
Odonata	Coenagrionidae	Damselfly	*Ischnura heterosticta*	3	0.79
Lepidoptera	Erebidae	Clover looper moth	*Caenurgina crassiuscula*	4	1.05
		Handmaiden moth	*Amata cyssea*	4	1.05
	Nymphalidae	Lemon pansy	*Junonia lemonias*	3	0.79
		Peacock pansy	*J. almana*	5	1.30
		Grey pansy	*J. atlites*	4	1.05
		White four-ring	*Ypthima ceylonica*	3	0.79
	Crambidae	Plam leafroller moth	*Herpetogramma abdominalis*	5	1.30
	Pieridae	Common grass yellow	*Eurema hecabe*	3	0.79
	Lycaenidae	Common grass blue	*Zizina labradus*	3	0.79
		Common grass blue	*Z. otis*	6	1.57

Devi et al*.,* 2017), comprising one species (*Ischnura heterosticta)* belonging to the Coenagrionidae family.

Diptera was the most dominant order (176 individuals) on the mustard crop. The recorded Diptera order relative abundance was (45.52%) significantly higher than Hymenoptera (42.67%) and Lepidoptera (10.48%). In orchard fields in Paharpani Nainital, Uttarakhand India, Deeksha et al*.* (2022) observed a relative abundance of Lepidoptera (54.3%), Hymenoptera (20%), and Diptera (11.60%). However, the lowest relative abundance was recorded for Odonata (0.79%). *A. mellifera* was the most prevalent species, accounting for 14.92% of the total insect visitation, as evidenced by its relative abundance. This was succeeded by *A. cerana*, the second most prevalent insect visitor, which accounted for 9.95% of the insect fauna.

In the BARI Sarisha-17 (*Brassica rapa* L.) fields at the University of Rajshahi, insect pollinator diversity was notably high. The Shannon-Wiener Index (H') was 3.0448, and the Simpson Index was 0.9413, indicating a diverse and balanced community. An Evenness Index of 0.8708 suggests a uniform distribution of individuals among species, while the Margalef Richness Index of 32.83 reflects substantial species richness. These findings underscore the ecological value of BARI Sarisha-17 fields for supporting diverse pollinator assemblages. Deeksha et al*.* (2022), Usha and John (2015), and Subedi and Subedi (2019) all found diversity indices that are in agreement with the ones found in the present research.

4. CONCLUSION

The study finds a vast diversity and even distribution of insect pollinators in BARI Sarisha-17 (*Brassica rapa* L.) fields at the University of Rajshahi indicating a healthy and stable pollinator community. These findings highlight the ecological importance of pollinators in magnifying crop productivity through effective pollination services. Preserving such agroecosystems is essential for maintaining biodiversity and supporting sustainable agriculture and food security in the region.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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