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Simpson's index of diversity of insect pests and natural enemies inhabiting the rapeseed mustard (*Brassica juncea*) agroecosystem in the Kanpur region of Uttar Pradesh (India)

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Abstract
This study investigated the diversity and succession of insect pests and their natural enemies in the rapeseed mustard (*Brassica juncea*) agroecosystem in the Kanpur region of Uttar Pradesh, India, during the *Rabi* seasons of 2023-24 and 2024-25. Key pests identified were the mustard sawfly (*Athalia lugens proxima*), mustard aphid (*Lipaphis erysimi*), and painted bug (*Bagrada cruciferum*). Natural enemies observed included ladybird beetles (*Coccinella* spp.) and syrphid flies (*Spilomyia longicornis*). Seasonal incidence patterns were recorded for each species, with pest activity and predator populations showing correlation with meteorological parameters. For instance, the mustard sawfly appeared during the vegetative stage, while aphids peaked later in the season. Ladybird beetles and syrphid flies generally increased in numbers as aphid populations grew, indicating their role as biocontrol agents.
A relative abundance analysis for the 2023-24 season revealed that aphids (*Lipaphis erysimi*) were overwhelmingly dominant, constituting 92.22% of the total observed insects. This dominance, along with lower numbers of other species, resulted in a low Simpson's Index of Diversity (SID) of 0.14, indicating a less diverse ecosystem. Similar trends were observed in the 2024-25 season, where aphids represented 88.54% of the population, leading to an SID of 0.21. The study highlights the significant impact of specific pests, particularly aphids, on the ecosystem's diversity.

Keywords: Diversity, Natural enemies, correlation, biocontrol agents, Simpson's Index of Diversity

1. Introduction
Mustard (*Brassica juncea*) is a major winter (*Rabi*) season oilseed crop grown mainly in northern parts of India. Farmers generally start sowing during late October and continue until late November. The crop starts flowering in the months of December to January, and the harvesting season starts mainly from mid-February to April. Mustard seed is the third biggest source of vegetable oil in the world after soybean oil and palm oil. Oil content in rapeseed and mustard varies from 33% to 46%, and average oil recovery is around 32% to 38%. After oil extraction, the remaining part of the seed is used to produce rapeseed/mustard cake, an important component of cattle and poultry feed.
Indian mustard is grown over an area of 8.06 million hectares with a production of 11.75 million tonnes and productivity of 1524 kg/ha during 2021-22 (Anonymous, 2023) [1]. However, in Uttar Pradesh during the year 2021-2022, the area of rapeseed-mustard was 0.76 million hectares, and production was 1.03 million tonnes with low productivity of 1438 kg/ha as compared to Haryana, which had the highest productivity of 2028 kg/ha in a 0.71-million-hectare area with 1.37 million tonnes of production. In UP, Mathura district has the highest area, production, and productivity, which are 0.053 million hectares, 0.077 million tonnes, and 1453 kg/ha. In the world, during 2017-2018, rapeseed-mustard occupied almost 36.68 million ha of area, with a total production of 70.42 million tonnes and 1920 kg/ha productivity (Anonymous, 2023) [1]. Broadly, seven species of *Brassica spp.* are grown in India. The most popular species grown in the Indian subcontinent are *Brassica juncea*, *Brassica campestris* and *Brassica napus*. Indian mustard (*Brassica juncea*) is highly valuable and has been cultivated for centuries as an oil plant. Rajasthan and Uttar Pradesh are the major mustard-producing states in the country.

Together, they produce about 50% of the mustard. Being an important source of edible oil and feed meal to the country, rapeseed is undoubtedly the focus of the Indian oilseed industry. The oil is also used as hair oil and as a lubricant. The oil of cultivars bred for extra high erucic acid content is used for industrial purposes.

But a wide gap exists between the potential yield and the yield realised at the farmer's field, which is largely because of the number of biotic and abiotic stresses to which the rapeseed-mustard crop is exposed. It has been reported that approximately 15 species of insect pests cause damage to mustard, *viz.*, mustard aphid (*Lipaphis erysimi* Kalt), mustard sawfly (*Athalia lugens proxima* Klug.), painted bug (*Bargrada cruciferum* Kirk), leaf miner (*Phytomga horticola* Gour.), Bihar hairy caterpillar (*Spilosoma oblique* Walker), peach aphid (*Myzus persicae* Sulzer), cabbage aphid (*Brevicorynae brassicae* Linn.), cotton aphid (*Aphis gossypii* Walker), cabbage butterfly (*Pieris brassicae* Linn.), diamondback moth (*Plutella xylostella* Linn.), whitefly (*Bemisia tabaci Genn.)*, cutworm (*Agrotis segatum* Dennis & Schiff) and stem fly (*Melanagromyza cleome* Spencer) are the pests of major importance. Among them, the mustard aphid (*Lipaphis erysimi* Kalt), Aphididae: Homoptera, is one of the most destructive insects, causing a severe reduction in seed yield ranging from 15.0 to 73.3% (Bakhetia and Sekhon, 1989; Rohilla *et al.*, 1990) [2, 17].

So, studying the diversity of insect pests and natural enemies in the mustard agro-ecosystem will be helpful in developing sustainable pest management strategies. The study will help in understanding the specific pests and insects present in the locality. It will also allow for targeted and effective control measures. Consequently, it will reduce reliance on broad-spectrum pesticides and foster ecological equilibrium.

2. Materials and Methods

Table 2.1: Details of the layout of study on diversity and succession of insect pests and their natural enemies inhabiting the mustard agroecosystem

Crop	Mustard
Variety	Vaibhav
Plot size	10×10 m
Spacing row to row	45 cm
Spacing plant to plant	15 cm

The appearance of insect pests and their natural enemies, including predators and parasitoids inhabiting the mustard agroecosystem, was observed at weekly intervals from the seedling stage of mustard to the maturity of the crop. The mustard variety Vaibhav was sown in a plot size of 10 × 10 meters by adopting 45 cm row-to-row and 15 cm plant-to-plant spacing during the first fortnight of the December 2023-24 and December 2024-25 cropping seasons. The incidence of insect pests and natural enemies was observed visually at weekly intervals throughout the cropping season. The qualitative diversity of insect pests and their natural enemies was categorised into different groups based on their occurrences. Insect pests and their natural enemies that continuously infested the crop in considerable numbers after their initial appearance were classified as major, while those that occurred intermittently and never reached high populations were classified as minor. Species that appeared rarely with very low populations were designated as stray. The relative abundance of insect pests and their natural enemies for the complete cropping season from seedling to crop maturity stage was calculated by the formula given below:

$$Relative\ abundance\ (\%) = \frac{No.of\ individuals\ insect\ pests\ \&\ natural\ enemies}{No.of\ individuals\ of\ all\ species} \times 100$$

Species diversity of the site was quantified using Simpson's index (D) (Simpson, 1949). Simpson's index (D) is the measure of diversity which accounts for the number of species present, as well as the relative abundance of each species. Simpson's index (D) was calculated by using the formula:

Where-

D = Total sum of H (H-1) / N(N-1)

H = Total no. of individuals of a particular species.

N = Total no. of individuals of all species (insect pests and natural enemies).

Subtracting the value of the Simpson's index (D) from 1 will provide the Simpson's index of diversity (SID). The value of SID will range from 0 to 1. The greater the SID value, the greater the sample diversity.

The infestation of insect pests at different crop growth stages (crop phenology) was also recorded from the seeding stage to the crop maturity stage.

Table 2.2: Mode of observations for insect pests and predators present in the agroecosystem

S. No.	Insects pests	Mode of observation
1.	Mustard sawfly	No. of grubs/plants/plot
2.	Mustard aphid	No. of aphids/10 cm central twig on plants/plot
3.	Painted bug	No. of bugs (nymphs and adults)/plants/plot.
	Natural enemies (Predator)	
1.	*Coccinella spp.*	No. of grubs and adults/plant/plot
2.	Syrphid flies	No. of maggot and adults/plant/plot

3. Results and Discussion

3.1 Incidence of mustard sawfly (*Athalia lugens proxima*)

According to table 3.1 and 3.2 during the *Rabi* seasons of 2023-24 and 2024-25, mustard sawfly infestations were observed to follow a seasonal pattern, with the pest first appearing during the vegetative stage of crop growth. In 2023-24, the initial presence was recorded in the 45th meteorological week, peaking at 1.15 grubs per plant by the 48th week before declining and disappearing by the 51st week. The severe infestation during this season was associated with temperatures between 12.70 °C and 25.20 °C, relative humidity ranging from 61.00% to 94.00%, wind speed of 2.10 km/hr, and 6.60 mm of rainfall. The following season, 2024-25, saw an earlier emergence in the 45th week

with activity continuing through the 50th week, reaching a higher peak of 2.10 grubs per plant in the 47th week. This infestation was marked by cooler minimum temperatures (9.80 °C), slightly warmer maximum temperatures (26.70 °C), lower humidity (45.80% to 92.20%), reduced wind speed (1.60 km/hr), and no rainfall. These observations demonstrated the need for timely monitoring to manage sawfly populations and mitigate crop damage effectively.

The present results on the seasonal incidence of mustard sawfly are in close agreement with the results of Parija *et al*. (2023) [11], who reported the incidence of mustard sawfly (12 larvae per plant at 48th SMW), and are also strongly supported by Patel *et al.* (2022) [12], who reported the maximum incidence of sawfly was recorded during 47th SMW (1.30 larvae/plant), and are also supported by Pal *et al*. (2020) [10], who observed the mustard sawfly, *Athalia lugens proxima* (Klug.), at the seedling stage. The minimum population (0.30) was found in the 48th standard meteorological week and the maximum population (3.60) in the 46th standard meteorological week. Pal and Debnath (2020) [10] reported that maximum intensity of mustard sawfly was observed in the middle of January, when the crop was in the flower bud formation stage. Pradhan *et al*. (2020) [15] revealed that the mustard sawfly (*A. lugens proxima*) appeared during the 51st SMW, i.e., the 3rd week of December. Similar work had been reported by Pradhan *et al*. (2020) [15], who observed the infestation of mustard sawfly began in the third week of December and lasted until the last fortnight of February.

3.2 Incidence of mustard Aphids (*Lipaphis erysimi*)

According to table 3.1 and 3.2 during the *Rabi* seasons of 2023-24 and 2024-25, mustard aphid (*Lipaphis erysimi*) infestations exhibited notable temporal and climatic variation. In 2023-24, aphid colonisation began in the 51st Standard Meteorological Week (SMW) and peaked in the 5th SMW with an average density of 108.30 aphids per 10 cm of central twig per plant. The infestation was most severe under conditions of 11.60 °C minimum temperature, 26.50 °C maximum temperature, 45% minimum and 87% maximum relative humidity, 4.40 km/h wind speed, and 6.60 mm rainfall. In contrast, during 2024-25, aphid activity commenced a week later in the 52nd SMW and peaked in the 7th SMW with a slightly lower density of 95.40 aphids per 10 cm twig. The highest infestation occurred under slightly warmer and drier conditions: 11.80 °C minimum temperature, 28.10 °C maximum temperature, 38% minimum and 80% maximum relative humidity, 5.80 km/h wind speed, and no rainfall. These findings highlight the influence of microclimatic factors on aphid population dynamics and emphasise the need for timely monitoring and adaptive pest management strategies.

The present results are in accordance with the results of Kumar *et al*. (2024) [5], who reported the occurrence of mustard aphid started from the 52nd Standard Week (SW) and continued till harvest (12th SW). The population ranged from 0.15 to 26.31, 0.11 to 259.34 and 0.03 to 305.49 aphids/10 cm central twig/plant, respectively, on timely, mid-late and late-sown crops. Srija *et al*. (2024) [19] found the highest population of mustard aphids at 6th SMW (9.65 aphids/10 cm apical shoot). Pal *et al*. (2020) [10] observed mustard aphid, *Lipaphis erysimi* (Kalt.), appearing from the flowering to pod-bearing stage of the rapeseed mustard crop. Pradhan *et al*. (2020) [15] revealed that the aphid (*L. erysimi*) appeared during the 51st SMW, i.e., the 3rd week of December. Pal and Debnath (2020) [10] noticed the maximum aphid population during the 2nd week of February at the fruiting stage of the crop. Patel *et al*. (2019) [13] have found that the mustard aphid, *L. erysimi* (Kalt.), occurs continuously in a sizeable population, causing noticeable damage from the flowering to maturity stage of the crop.

3.3 Incidence of mustard Painted bug (*Bagrada hilaris*)

According to table 3.1 and 3.2 during the *Rabi* season of 2023-24, painted bug infestation on the crop varied from 0.10 to 1.95 bugs per plant and peaked at 2.40 bugs per plant in the 9th SMW (spanning SMW 3-11). This outbreak coincided with moderate temperatures (13.5-25.5 °C), relative humidity between 51% and 83%, a wind speed around 5.1 km/hr and 32.2 mm of rainfall; the most severe infestation occurred under slightly wider temperature (9.8-26.7 °C) and humidity (45.8-92.2%) ranges, with lighter winds (1.6 km/hr) and no rain. In contrast, the 2024-25 *Rabi* season saw infestation levels between 0.10 and 1.65 bugs per plant, peaking at 1.65 in the 8th SMW (SMW 4-11th), under conditions of 11.7-27.8 °C, 39-84% relative humidity, an average wind speed of 3.8 km/hr and zero recorded rainfall.

The present results are in accordance with the results of Pratihar *et al*. (2024) [16], who reported the incidence of painted bug, *Bagrada hilaris* (Kirk.) infestation, was observed twice during the cropping season. The first infestation was recorded in the 45th SMW (0.60 bugs plant^{-1}), and the second infestation occurred from the 8th SMW to the 10th SMW (5.13 bugs plant^{-1}). Patel *et al*. (2022) [12] reported that the highest incidence of the painted bug was observed in the 8th SMW, with a count of 2.50 bugs per plant. Pal *et al*. (2020) [10] found that the incidence of the painted bug, *Bagrada cruciferarum* (Kirk.), was observed at two different crop stages: firstly, at the seedling stage and secondly, at the maturity stage of the crop. Patel *et al*. (2019) [13] found the incidence of the painted bug, *Bagrada cruciferarum*, during the seedling-to-maturity stage at a low level of population, causing negligible damage. Lal *et al*. (2018) [7] found that the appearance of painted bugs began during the 47th SMW and reached its peaks during the 8th SMW.

3.4 Occurrence of Ladybird Beetles as Biocontrol Agents of Mustard Aphids

According to table 3.1 and 3.2 during the *Rabi* seasons of 2023-24 and 2024-25, monitoring of *Coccinella* spp. (ladybird beetles) revealed a consistent upward trend in predator density, highlighting their effective role as biocontrol agents. In 2023-24, beetle counts rose from 0.05 per plant in the 1st SMW to a peak of 3.10 by the 10th SMW, while in 2024-25, counts increased from 0.10 per plant in the 2nd SMW to a maximum of 5.20 by the 8th SMW. The highest beetle occurrences were associated with favourable weather conditions: in 2023-24, these included a minimum temperature of 10.80 °C, a maximum of 26.40 °C, relative humidity ranging from 40% to 73%, wind speed of 5.10 km/h, and no rainfall; in 2024-25, optimal conditions were slightly warmer and more humid, with temperatures between 11.70 °C and 27.80 °C, humidity from 39% to 84%, wind speed of 3.80 km/h, and again, no rainfall. These findings underscore the climatic influence on predatory establishments and their potential for pest management.

The current results are in close agreement with the results of Kapure *et al.* (2024) [3]: ladybird beetles were recorded in the range of 1.20 to 7.34 grubs and adults/plant and had their peak activity during the 5th SMW. Pradhan *et al.* (2020) [15] revealed that the ladybird beetle appeared during the 4th SMW. Lal *et al.* (2018) [7] observed that the activity of *D. rapae* and *C. septumpunctata* started from the 4th SMW and reached its peak on the 9th SMW, respectively.

3.5 Occurrence of Syrphid fly as a Biocontrol Agent of Mustard Aphids

According to table 3.1 and 3.2 during the two successive *Rabi* seasons, both syrphid flies and ladybird beetles established progressively higher field densities, underscoring their value as biocontrol agents. In 2023-24, syrphid maggot populations rose from just 0.10 maggots per plant in SMW 3 to a maximum of 3.40 maggots per plant by SMW 10, with the peak coinciding with minimum and maximum temperatures of 10.8 °C and 26.4 °C, relative humidity between 40% and 73%, a light wind at 5.1 km/h^{-1}, and zero rainfall. The following season, 2024-25, saw ladybird beetle numbers climb from 0.25 beetles per plant in SMW 3rd to 5.20 beetles per plant by SMW 8th, thriving under similar conditions temperatures of 11.7-27.8 °C, humidity ranging from 39% to 84%, a gentle breeze of 3.8 km/h^{-1}, and no precipitation highlighting consistent climatic preferences for optimal predator performance.

The present findings are in accordance with the finding of Kumar *et al.* (2024) [5], who reported that the syrphid fly (*Episyrphus balteatus* spp. (unidentified), *Cheilomenes sexmaculata*) was recorded at different stages of the crop growth. The population of predators was significantly increased with an increase in the aphid population from 7th to 10th SW among the different dates of sown crops. Pradhan *et al.* (2020) [15] reported that the syrphid fly, *Xanthogramma cutellaris*, was a major predator of aphids. Kapure *et al.* (2024) [3] reported the Syrphid flies in the scale of 1.00 to 2.60 maggots/plant had their peak activity during the 5th SMW.

3.6 Relative abundance of insect pests and eco-friendly fauna inhabiting mustard (*Brassica juncea*)

According to Table 3.3 and 3.4 during the *Rabi* seasons of 2023-24 and 2024-25, a detailed survey of the mustard (*Brassica juncea*) agro-ecosystem identified five insect species three pests and two natural enemies—representing five orders (Hymenoptera, Homoptera, Hemiptera, Coleoptera, and Diptera) and six families. These species were classified by feeding behaviour into pests and predators, then further categorised by occurrence patterns as regular (persistent in significant numbers after first appearance) or occasional (sporadic surges or absent before harvest).

The present findings are in accordance with the finding of Karthik *et al.* (2022) [4], who reported the insect pests mustard aphid species (*Lipaphis erysimi pseudobrassicae*, *Myzus persicae*) were dominant in both years with relative abundances of 73.46% and 76.70%, respectively. Amongst natural enemies, *Coccinella septempunctata* (14.66 and 16.36%) and *Diaeretiella rapae* (21.97 and 17.89%) were dominant in both years, respectively.

3.6.1 Relative Abundance and Diversity Index of mustard insect pests

According to Table 3.3 and 3.4 during the *Rabi* 2023-24 & 2024-25 seasons in a mustard (*Brassica juncea*) agro-ecosystem, aphids (*Lipaphis erysimi*) were overwhelmingly dominant, with 5,860 individuals accounting for 92.22% of the total records. The next most abundant predators and pests were ladybird beetles (*Coccinella spp*.) at 190 individuals (2.99%), syrphid flies (*Spilomyia longicornis*) at 164 (2.58%), painted bugs (*Bagrada cruciferum*) at 96 (1.51%), and the mustard sawfly (*Athalia lugens proxima*) at just 44 (0.69%). This pronounced dominance by a single species is reflected in a Simpson's Index (D) of 0.85 and a Simpson's Index of Diversity (SID) of 0.14, indicating low overall diversity within the community.

The present findings are in accordance with the finding of Karthik *et al.* (2022) [4], who reported the diversity indexes of insect pests and natural enemies with respect to the Shannon index (H = 0.78, 1.54), richness (M.I. = 6.34, 7.18), and evenness (J = 0.23, 0.45) were higher during 2020-2021.

Table 3.1: Diversity and succession of insect pests and their natural enemies inhabiting the mustard agroecosystem during *Rabi* 2023-24

SMW	No. of sawfly/plant	No. of Aphids/10 cm	No. of bugs/Plants	Coccinella spp.	Syrphid spp.	T. Max.	T. Min.	RH Max.	RH Min.	W. Speed	Rainfall	Evaporation	Sunshine
45	0.25	0.00	0.00	0.00	0.00	30.40	14.60	92.00	45.00	1.50	0.00	8.70	0.20
46	0.65	0.00	0.00	0.00	0.00	27.50	12.90	93.00	62.00	1.60	0.00	8.20	0.00
47	0.90	0.00	0.00	0.00	0.00	26.80	11.40	94.00	54.00	1.70	0.00	8.90	0.00
48	1.15	0.00	0.00	0.00	0.00	25.20	12.70	94.00	61.00	2.10	6.60	8.40	0.00
49	0.85	0.00	0.00	0.00	0.00	24.20	13.20	92.00	65.00	2.50	11.80	9.00	0.00
50	0.40	0.00	0.00	0.00	0.00	24.60	8.40	94.00	46.00	2.40	0.00	8.20	0.00
51	0.15	2.50	0.00	0.00	0.00	22.70	7.60	90.00	47.00	2.60	0.00	8.20	0.00
52	0.00	7.20	0.00	0.00	0.00	19.90	8.30	95.00	69.00	2.10	0.00	9.20	0.00
1	0.00	5.20	0.00	0.05	0.00	16.80	10.00	95.00	81.00	2.20	11.20	8.60	0.00
2	0.00	9.85	0.00	0.15	0.00	16.40	5.50	96.00	72.00	3.20	0.00	7.60	0.00
3	0.00	28.25	0.20	0.40	0.10	12.50	5.30	92.00	77.00	2.80	0.00	7.00	0.00
4	0.00	65.80	0.70	0.85	0.40	17.70	5.10	95.00	63.00	2.90	0.00	7.90	0.00
5	0.00	92.25	1.00	1.50	0.85	23.10	9.00	92.00	55.00	4.10	0.00	9.60	1.70
6	0.00	72.50	1.55	2.30	0.60	21.50	9.30	88.00	54.00	5.20	26.80	9.60	4.70
7	0.00	65.60	1.10	1.80	1.15	26.00	10.10	92.00	48.00	2.30	0.00	8.00	3.60
8	0.00	108.30	1.95	2.75	2.90	26.50	11.60	87.00	45.00	4.40	0.60	9.60	6.70
9	0.00	75.45	2.40	2.20	2.50	25.50	13.50	83.00	51.00	5.10	32.20	12.00	5.70
10	0.00	40.35	0.60	3.10	3.40	26.40	10.80	73.00	40.00	5.10	0.00	16.40	9.50
11	0.00	12.70	0.10	2.35	2.65	30.00	13.30	78.00	36.00	2.60	0.00	15.60	8.10
12	0.00	0.00	0.00	1.55	1.80	30.80	14.00	75.00	37.00	4.80	0.00	17.00	7.60

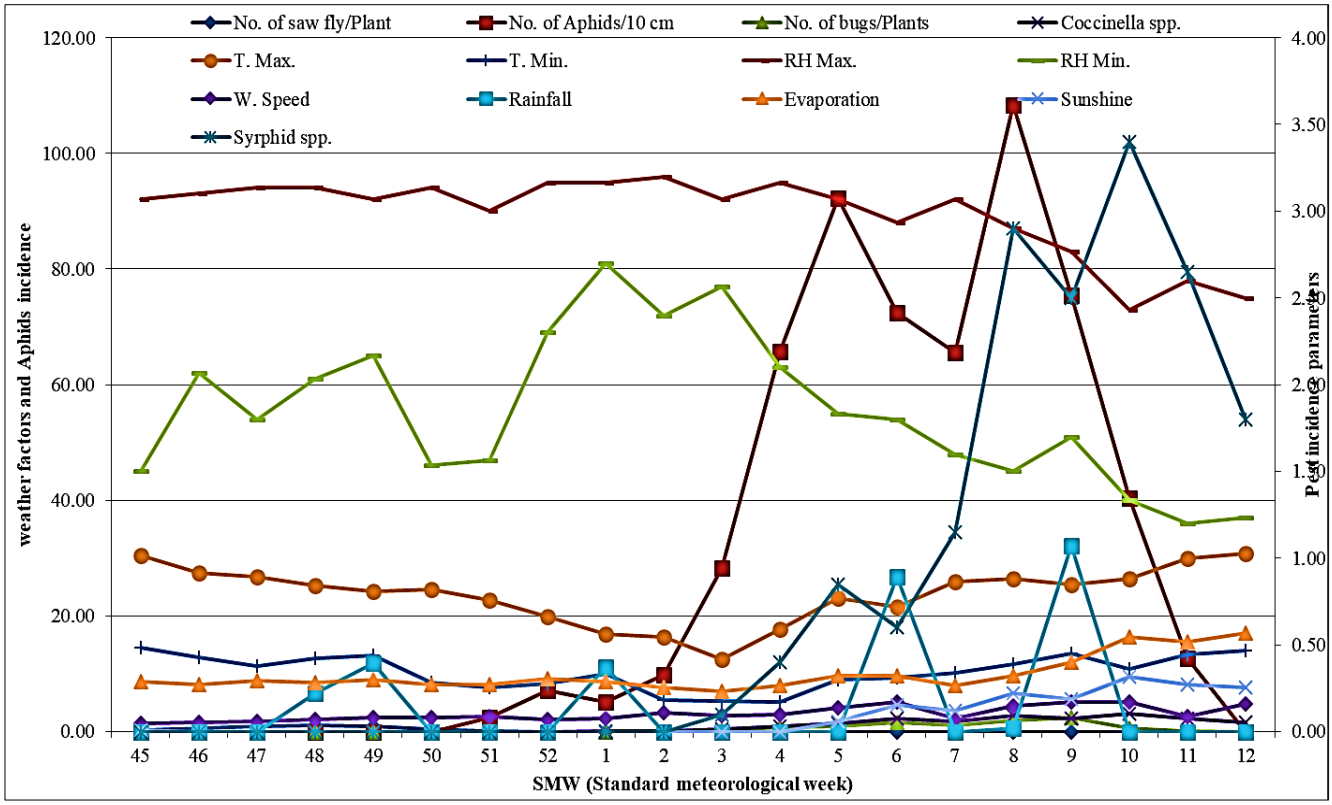

Fig 3.1: Diversity and succession of insect pests and their natural enemies inhabiting the mustard agroecosystem during *Rabi* 2023-24

Table 3.2 Diversity and succession of insect pests and their natural enemies inhabiting the mustard agroecosystem during *Rabi* 2024-25

SMW	No. of sawfly/plant	No. of Aphids/10 cm	No. of bugs/Plants	Coccinella spp.	Syrphid spp.	T. Max.	T. Min.	RH Max.	RH Min.	W. Speed	Rainfall	Evaporation	Sunshine
45	0.15	0.00	0.00	0.00	0.00	32.00	17.40	91.00	54.00	1.00	0.00	1.50	0.90
46	0.45	0.00	0.00	0.00	0.00	30.80	14.20	94.00	43.00	2.10	0.00	1.30	0.00
47	0.80	0.00	0.00	0.00	0.00	26.70	11.50	90.00	48.00	1.60	0.00	1.20	0.00
48	1.00	0.00	0.00	0.00	0.00	26.70	9.80	92.20	45.80	1.60	0.00	1.20	6.60
49	0.75	0.00	0.00	0.00	0.00	26.80	10.00	80.00	34.00	3.00	0.00	1.60	6.20
50	0.35	0.00	0.00	0.00	0.00	23.40	7.30	80.00	33.00	4.40	0.00	1.70	4.90
51	0.10	0.00	0.00	0.00	0.00	24.40	6.10	90.00	45.20	1.50	0.00	1.20	1.50
52	0.00	1.35	0.00	0.00	0.00	22.40	11.70	91.40	66.80	4.10	0.20	1.20	0.00
1	0.00	3.50	0.00	0.00	0.00	15.20	7.30	91.00	79.00	3.40	0.00	1.10	0.00
2	0.00	7.80	0.00	0.10	0.00	19.10	6.60	95.00	61.10	3.30	0.30	1.10	0.00
3	0.00	28.30	0.00	0.50	0.25	21.70	9.20	90.00	60.00	5.30	0.00	1.20	2.70
4	0.00	42.60	0.30	1.10	0.40	24.50	8.20	83.00	36.00	5.00	0.00	1.70	7.70
5	0.00	65.20	0.80	2.40	0.90	27.20	9.20	91.00	39.00	2.70	0.00	1.50	5.50
6	0.00	81.70	1.00	3.90	1.40	25.80	10.10	75.00	38.00	6.40	0.00	2.10	8.70
7	0.00	95.40	1.25	4.60	2.30	28.10	11.80	80.00	38.00	5.80	0.00	2.50	9.20
8	0.00	72.50	1.65	5.20	3.80	27.80	11.70	84.00	39.00	3.80	0.00	2.50	7.30
9	0.00	55.80	1.00	4.30	5.00	29.40	14.90	80.00	41.00	4.70	0.00	2.40	5.50
10	0.00	30.25	0.50	3.50	4.20	29.70	11.90	70.00	31.00	7.50	0.00	3.10	9.10
11	0.00	12.60	0.10	2.70	3.30	33.40	17.40	72.00	32.00	4.10	0.00	3.10	8.80
12	0.00	0.00	0.00	1.80	2.50	32.90	13.30	73.00	32.00	3.20	0.00	3.30	9.20

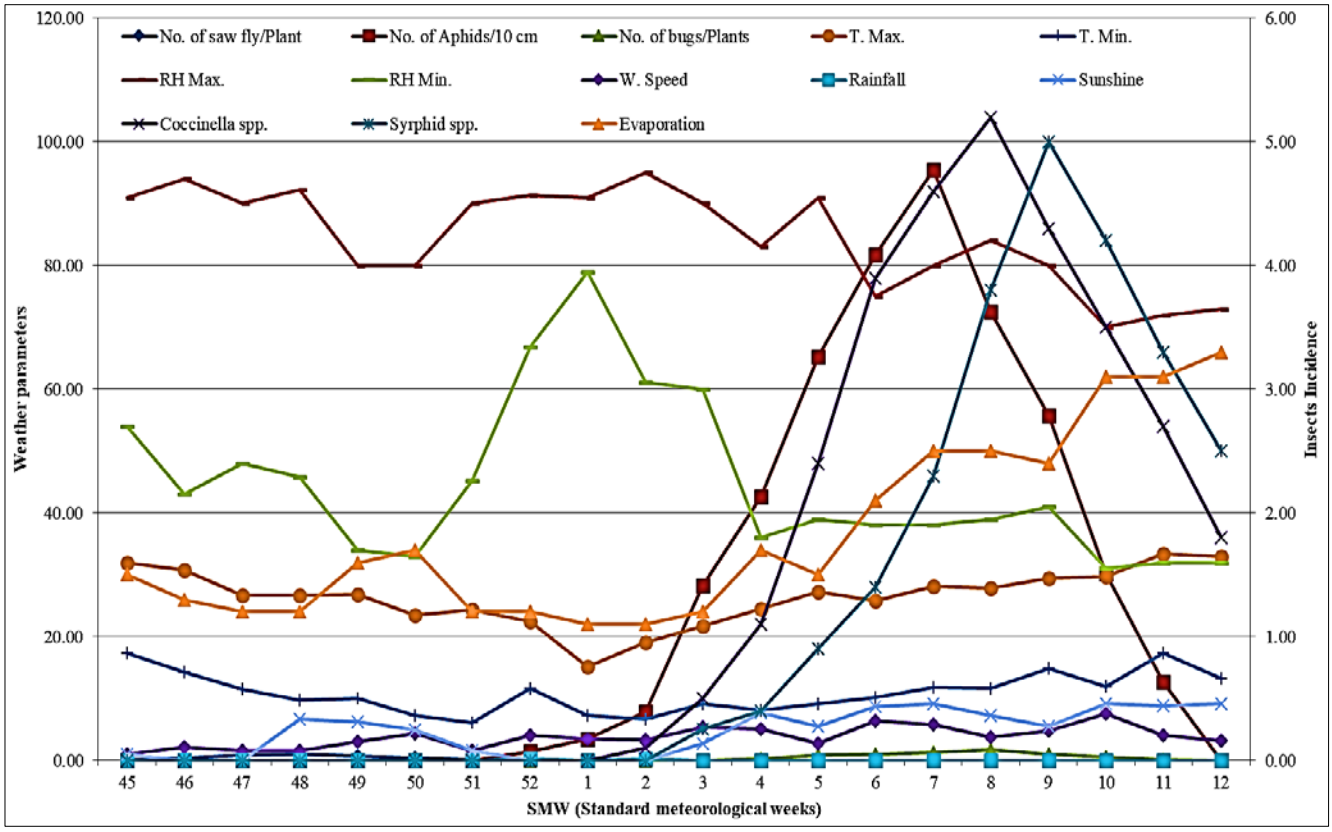

Fig 3.2: Diversity and succession of insect pests and their natural enemies inhabiting the mustard agroecosystem during *Rabi* 2024-25

Table 3.3: Relative abundance of insect pests and eco-friendly fauna inhabiting mustard (*Brassica juncea*) ecosystem, 2023-24

S. No.	Common Name	Scientific Name	Order	Family	Total no. of insects observed	Relative abundance (%)
1.	Mustard sawfly	*Athalialugens proxima*	Hymenoptera	Tenthredinidae	44.00	0.69%
2.	Aphids	*Lipaphis erysimi*	Homoptera	Aphididae	5860.00	92.22%
3.	Painted bug	*Bargrada cruciferum*	Hemiptera	Pentatomidae	96.00	1.51%
4.	Coccinella spp.	*Coccinella spp.*	Coleoptera	Coccinellidae	190.00	2.99%
5.	Syrphid spp.	*Spilomyia longicornis*	Diptera	Syrphidae	164.00	2.58%
Total no. of insects					6354	
Simpson's Index (D)					0.85	
Simpson's Index of Diversity (SID)					0.15	

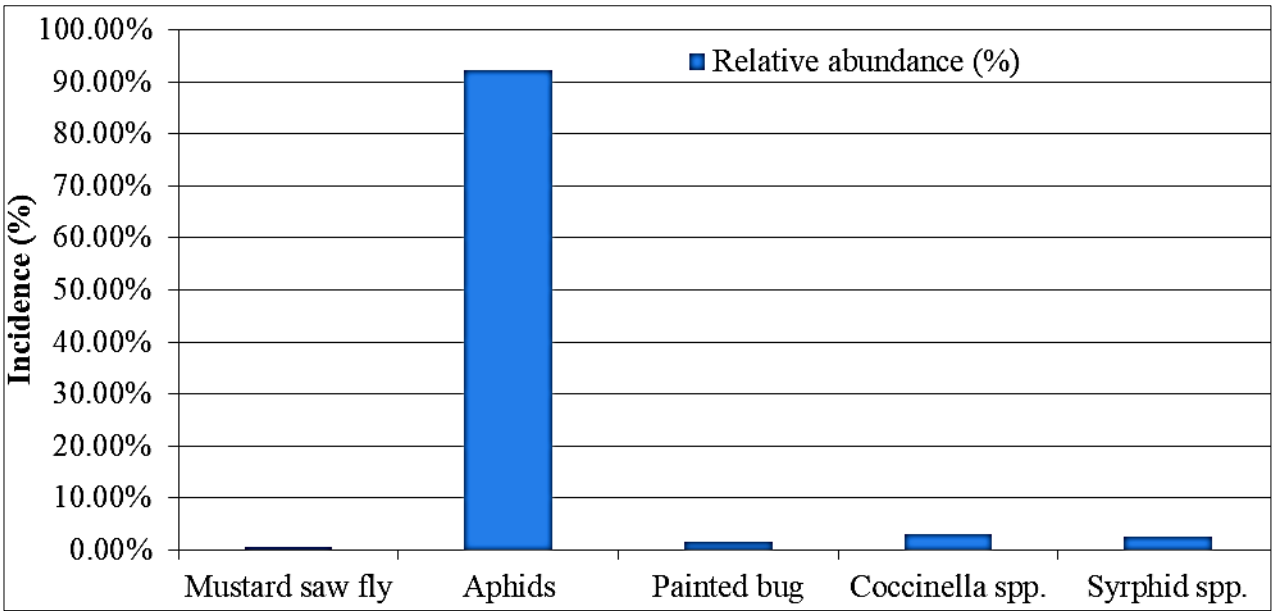

Fig 3.3: Relative abundance of insect pests and eco-friendly fauna inhabiting mustard (*Brassica juncea*) agroecosystem 2023-24

Table 3.4: Relative abundance of insect pests and eco-friendly fauna inhabiting mustard (*Brassica juncea*) ecosystem, 2024-25

S. No.	Common Name	Scientific Name	Order	Family	Total no. of insects observed	Relative abundance (%)
1.	Mustard sawfly	*Athalialugens proxima*	Hymenoptera	Tenthredinidae	36.00	0.64%
2.	Aphids	*Lipaphis erysimi*	Homoptera	Aphididae	4970.00	88.54%
3.	Painted bug	*Bargrada cruciferum*	Hemiptera	Pentatomidae	66.00	1.17%
4.	Coccinella spp.	*Coccinella spp.*	Coleoptera	Coccinellidae	301.00	5.36%
5.	Syrphid spp.	*Spilomyia longicornis*	Diptera	Syrphidae	240.00	4.27%
Total no. of insects					5613	
Simpson's Index (D)					0.78	
Simpson's Index of Diversity (SID)					0.22	

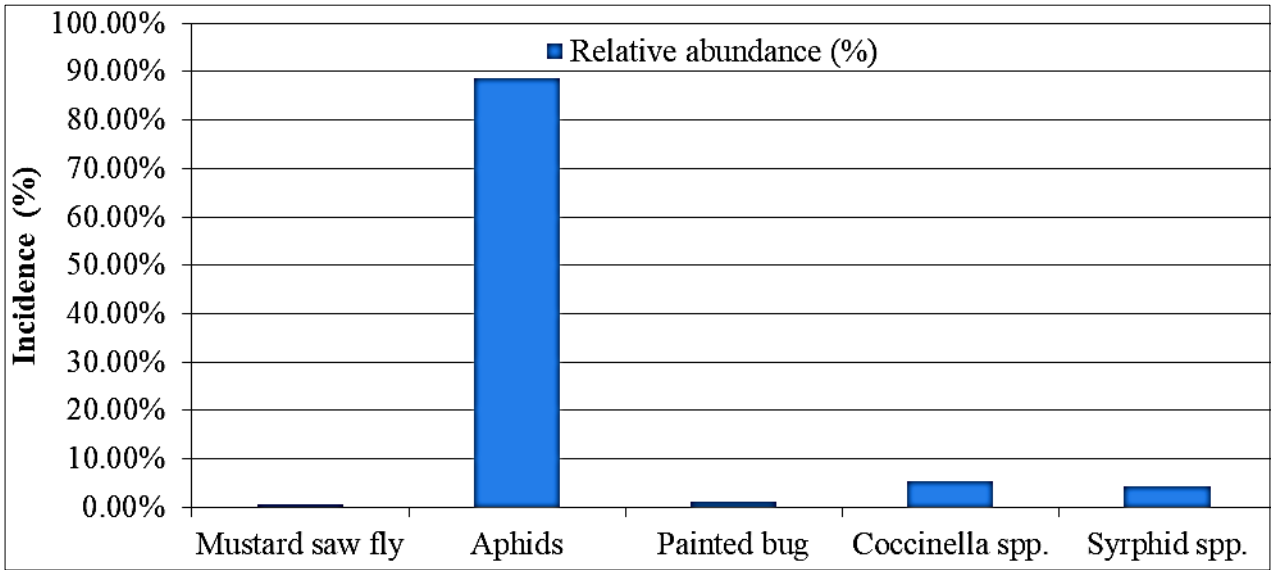

Fig 3.4: Relative abundance of insect pests and eco-friendly fauna inhabiting mustard (*Brassica juncea*) agro-ecosystem 2024-25

4. Conclusion

4.1 Incidence of Insect Pest Complex on Rapeseed Mustard

In 2023-24, the initial presence of mustard sawfly was recorded in the 45th meteorological week, peaking at 1.15 grubs per plant by the 48th week before declining and disappearing by the 51st week. The following season, 2024-25, saw an earlier emergence in the 45th week with activity continuing through the 50th week, reaching a higher peak of 2.10 grubs per plant in the 47th week.

In 2023-24, aphid colonisation began in the 51st Standard Meteorological Week (SMW) and peaked in the 5th SMW with an average density of 108.30 aphids per 10 cm of central twig per plant. In contrast, during 2024-25, aphid activity commenced a week later in the 52nd SMW and peaked in the 7th SMW with a slightly lower density of 95.40 aphids per 10 cm twig.

During the *Rabi* season of 2023-24, painted bug infestation on the crop varied from 0.10 to 1.95 bugs per plant and peaked at 2.40 bugs per plant in the 9th SMW (spanning SMW 3-11). In contrast, the 2024-25 *Rabi* season saw infestation levels between 0.10 and 1.65 bugs per plant, peaking at 1.65 in the 8th SMW (SMW 4-11th).

In 2023-24, ladybird beetle counts rose from 0.05 per plant in the 1st SMW to a peak of 3.10 by the 10th SMW, while in 2024-25, numbers increased from 0.10 per plant in the 2nd SMW to a maximum of 5.20 by the 8th SMW.

In 2023-24, syrphid maggot populations rose from just 0.10 maggots per plant in SMW 3 to a maximum of 3.40 maggots per plant by SMW 10. The following season, 2024-25, saw maggot numbers climb from 0.25 maggots per plant in SMW 3rd to 5.20 maggots per plant by SMW 8th.

4.2 Relative abundance of insect pests and eco-friendly fauna inhabiting mustard (*Brassica juncea*)

During the *Rabi* seasons of 2023-24 and 2024-25, a detailed survey of the mustard (*Brassica juncea*) agro-ecosystem identified five insect species three pests and two natural enemies representing five orders (Hymenoptera, Homoptera, Hemiptera, Coleoptera, and Diptera) and six families.

During the *Rabi* seasons of 2023-24 and 2024-25, the mustard (*Brassica juncea*) agro-ecosystem was heavily dominated by the aphid species *Lipaphis erysimi*, which comprised 92.22% of the total recorded individuals, with a count of 5,860. Other notable species included ladybird beetles (*Coccinella* spp.) with 190 individuals (2.99%), syrphid flies (*Spilomyia longicornis*) with 164 (2.58%), painted bugs (*Bagrada cruciferum*) with 96 (1.51%), and mustard sawflies (*Athalia lugens proxima*) with only 44 (0.69%). This overwhelming dominance by a single pest species resulted in a low biodiversity within the ecosystem, as reflected by a high Simpson's Index (D) of 0.85 and a low Simpson's Index of Diversity (SID) of 0.14.

References

1. Anonymous. Centre for Agriculture & Rural Development Policy Research (CARP). 2023. https://angrau.ac.in
2. Bakhetia DRC, Sekhon BS, Brar KS, Ghorbandi AW. Determination of economic threshold of *Lipaphis erysimi* (Kaltenbach) on Indian mustard. 1989.
3. Kapure VB, Neharkar PS, Matre YB. Seasonal incidence of major insect pests on mustard (*Brassica juncea* L.) and their correlation with weather

parameters. Int J Adv Biochem Res. 2024;SP-8(10):1397-1401.
4. Karthik S, Mukherjee U, Yashaswini G, Abhishek BM, Reddy MS. Abundance and diversity of insect pests and their natural enemies in the *Brassica campestris* (L.) crop ecosystem. J Entomol Res. 2022;46(3):597-602.
5. Kumar A, Mishra MK, Pandey R, Singh AK, Singh BK, Singh SSK, *et al*. Population dynamics of mustard aphid in relation to weather parameters and effect of predators on aphid population. Indian J Ecol. 2024;51(2):397-400.
6. Kumar R, Singh RS, Yadav N. Population dynamics of mustard aphid and its natural enemies. Indian J Entomol. 2024;84(1):168-170.
7. Lal B, Nayak MK, Srivastava AK, Tomar DS. Seasonal incidence of major insect pests of mustard and their natural enemies. Int J Chem Stud. 2018;6(3):3658-3661.
8. Pal DS, Singh DK, Gautam SP, Kumar A. Biorational management of mustard aphid, *Lipaphis erysimi* (Kalt.). Int J Chem Stud. 2020;8(2):2554-2557.
9. Pal DS, Singh DK, Gautam SP, Kumar A. Effect of biorational approaches for management of mustard aphid, *Lipaphis erysimi* (Kalt.), on seed yield and its economics. J Entomol Zool Stud. 2020;8(3):255-258.
10. Pal S, Debnath P. Seasonal incidence of major insect pests and predators of mustard in the lower Gangetic plains of West Bengal. J Entomol Zool Stud. 2020;8(6):1424-1430.
11. Parija S, Biswal L. Seasonal incidence of insect pests and predatory fauna on toria (*Brassica rapa*) in the West Central Tableland of Odisha, India. Int J Environ Clim Change. 2023;13(11):231-240.
12. Patel PK, Singh SK, Chandra U, Kumar V, Omar V. Succession of insect pest complex in rapeseed mustard. J Exp Zool India. 2022;25(2):1987-1991.
13. Patel S, Singh CP, Yadav SK. Monitoring of insect-pest complex on rapeseed-mustard at Pantnagar. J Entomol Res. 2019;43(1):73-76.
14. Pradhan PP, Borkakati RN, Saikia DK. Insect pests of mustard and their natural enemies in Assam. Int J Curr Microbiol Appl Sci. 2020;9(7):2785-2790.
15. Pradhan PP, Borkakati RN, Saikia DK. Seasonal incidence of insect pests and natural enemies of mustard in relation to meteorological parameters. J Entomol Zool Stud. 2020;8(1):1538-1542.
16. Pratihar AKS, Sundria MM, Pandey S. Seasonal incidence of insect pests of mustard (*Brassica juncea* L.) and their correlation with weather parameters: Mustard insect pest incidence and weather parameters. Ann Arid Zone. 2024;63(1):73-77.
17. Rohilla HR, Singh HS, Kumar PR. Preliminary screening of national varieties of *Brassica juncea* (L.) Czern. and Coss. against mustard aphid, *Lipaphis erysimi* (Kalt.). 1990.
18. Simpson GG. The species concept. Evolution. 1949;5(4):285-298.
19. Srija P, Shankar M, Reddy SS, Reddy VR. Seasonal incidence of major insect pests in relation to abiotic factors in mustard. J Adv Biol Biotechnol. 2024;27(8):851-856.