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Lepidopteran Fauna In Rabi Crops In An Agro-Ecosystem Of Shekhawati Region, Jhunjhunu (North-East Rajasthan)

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Abstract: The current study reports an assessment of Lepidopteran fauna on rabi crops in an agro-ecosystem of the Jhunjhunu district, Shekhawati region of North-east Rajasthan conducted during the winter season (Nov.2022 to March 2023). A total of 54 species from 12 families were recorded. The Noctuidae family was the most species-rich with 13 species, followed by Lycaenidae with 11 species, Pieridae with 8 species, Crambidae with 6 species, Erebidae and Nymphalidae with 4 species each, Papilionidae and Gelechiidae with 2 species each, and Hesperiidae, Geometridae, Scythrididae, and Plutellidae with 1 species each. In terms of abundance, 1,111 lepidopteran insects were collected. Lycaenidae was the most abundant with 432 individuals, followed by Noctuidae with 242, Pieridae with 150, Nymphalidae with 85, Crambidae with 78 , Papilionidae with 41, Erebidae with 40, Geometridae with 24, Gelechiidae with 8, Scythrididae with 7, and Hesperiidae and Plutellidae with 2 individuals each. Understanding key species and their seasonal distribution can help develop conservation strategies to promote sustainable agricultural practices.

Keywords: Species, Biodiversity, Lepidoptera, Rabi crops, Winter season

Introdution: Biodiversity supports ecosystems and their functional values. To understand the impact of anthropocentrism on the sustainable development of ecosystems, it is crucial to assess the species-diversity in the particular areas. (Mukherjee et al, 2015).

Primarily consisting of butterflies, moths, and skippers, Lepidoptera is the most enormous order. Butterflies have knobs on the tips of their antennae, are brilliantly colorful, and are diurnal. On the other hand, moths are primarily active at night. They frequently have dark colors with antennae that resemble combs, spindles, or threads.

They serve as ecological indicators in several processes such as nutrient cycling, seed dissemination, pollination, predation, parasitism, and pest management. They play role as a flagship species for studying biodiversity (Sharma and Dhadheech, 2013; Sharma, 2014; Singh et al, 2017; Choudhary et al, 2019). The various ecosysytems of Rajasthan have been investigated in the twenty-first century and made important contributions to the investigation of butterfly diversity (Palot and Soniya, 2000; Palot and Soniya, 2001; Kazmi et al, 2003; Ghorpade, 2016; Bhagat, 2020; Gehlot et al., 2021).

Environmental factors including as climate change, habitat fragmentation, pesticides, and pollution have led to a decline in the number of Lepidoptera species in recent decades. These undesirable traits had a negative impact on the natural ecology. Thus analyzing Lepidoptera biodiversity is crucial for conserving the micro-ecosystem by addressing seasonal changes and habitat fragmentation.

This study aims to assess the Lepidopteran fauna in rabi crops in an agro-ecosystem of Jhunjhunu district of Shekhawati region.

Materials and Methods:

Study Area: The study was carried out in an agro-ecosystem consisting of crop fields located in Chelasi village, which is 8 km from the sub-district headquarter Nawalgarh and 36 km south of the district head quarters Jhunjhunu. The study area covered 1000x500m, and the geographic coordinates were recorded using the Global Positioning System. The study area's central location was $27^0$53’39.69”N and $75^0$16’31.38” E.

Study Period: The study was conducted in an agro ecosystem from November 2022 to March 2023, using fortnightly sampling between 7A.M to 11A.M and 5P.M. to 7P.M. Rabi crops in the area are generally sown after the end of monsoons, preferably during the month of November and are harvested in the months of March or April. Mustard, gram, wheat, rapeseed, barley as major crops while carrot, cabbage, cauliflower, spinach, coriander, fenugreek, potato and onion were vegetable crops that are grown as the rabi crops.

Techniques and Methods: Lepidopteran insects were identified directly in the field by visual search method followed by capture or photography. The collection of moths was made with the help of vertical sheet light traps during night time. Butterflies and moths were also collected with hand held aerial sweep nets and killed with the help of ethyl acetate vapors. Dry preservation is done in fumigated ento-boxes and stored in the insect cabinets. Identifications were made following Talbot (1939, 1947), Hampson (1892, 1894, 1895, 1896) and

Bell and Scott (1937). Help from the Department of Entomology, Govt. Dungar College, Bikaner, Desert Regional Station of the Zoological Survey of India, Jodhpur, Krishi vigyan mahavidyalaya, Fatehpur and description and illustration from various pictorial guides, identification books etc. was also taken for identification and for confirmation.

Results:

In Lepidoptera, total 54 species belonging to the 12 families were recorded during present study (Table 1). The most diverse family was Noctuidae family with 13 species comprising 24%, followed by Lycaenidae with 11 species (20%), 8 species from Pieridae (14%), 6 species from Crambidae (11%), 4 species from Erebidae and Nymphalidae each (7%), 2 species from Papilionidae and Gelechiidae each (3.7%),1 species from Hesperiidae, Geometridae, Scythrididae, and Plutellidae each (1.8%) (Figure1).

The order of diversity of lepidopteran families was observed as:

Noctuidae> Lycaenidae > Pieridae > Crambidae > Erebidae, Nymphalidae > Papilionidae, Gelechiidae > Hesperiidae , Geometridae, Scythrididae, Plutellidae

Order Lepidoptera was represented by members belonging to the families Nymphalidae (*Danaus chrysippus, Junonia orithya, Junonia lemonias, Vanessa cardui*), Papilionidae (*Papilio demoleus, Papilio polytes*), Pieridae (*Belenois aurota, Eurema andersoni, Eurema hecabe, Eurema brigitta, Colotis amata, Catopsilia pyranthe, Catopsilia pomona, Pieris brassicae*), Lycaenidae (*Zizina otis, Zizeeria karsandra, Euchrysops cnejus, Zizula hylax, Anthene emolus, Chilades lajus, Spindasis vulcanus, Pseudozizeeria maha, Leptotes plinius, Catochrysops strabo, Rapala manea)*, Hesperiidae (*Suastus gremius*), Noctuidae (*Heliothis uncta, Heliothis peltigera, Helicoverpa armigera, Helicoverpa zea, Anticarsia irrorata, Agrotis ipsilon, Earias insulana, Earias vitella, Sesamia inferens, Spodoptera exigua, Spodoptera mauritia, Spodoptera frugiperda, Thysanoplusia orichalcea*), Crambidae (*Haritalodes derogate, Leucinodes orbonalis, Hellula undalis, Diaphania indica, Maruca testulalis, Spoladea recurvalis*), Erebidae (*Thyas coronata, Utetheisa pulchelloides, Utetheisa pulchella, Aloa lactinea*), Geometridae (*Traminda mundissima*), Scythrididae (*Eretmocera impectella*), Gelechiidae (*Pectinophora gossypiella, Tuta absoluta*) and Plutellidae (*Plutella xylostella*).

In terms of density, a total of 1,111 insects were collected from the study area. Among these, 432 individuals belonged to the Lycaenidae family (38.8%), 242 to the Noctuidae family (21.8%), and 150 to the Pieridae family (13.5%). Additionally, there were 85 individuals from the Nymphalidae family (7.6%), 78 from the Crambidae family (7.02%), 41 from the Papilionidae family (3.7%), 40 from the Erebidae family (3.6%), and 24 from the Geometridae family (2.1%). The collection also included 8 individuals from the Gelechiidae family (.72%), 7 from the Scythrididae family (.63%), and 2 each from the Hesperiidae and Plutellidae families (.18%).

The order of density of lepidopteran families was observed as : Lycaenidae > Noctuidae > Pieridae > Nymphalidae > Crambidae > Papilionidae > Erebidae > Geometridae > Gelechiidae > Scythrididae > Hesperiidae , Plutellidae

The month-wise density of Lepidopteran families in the study area has yielded significant insights into the distribution and abundance of these insect populations. A total of 1111 insects were collected during this period, encompassing a diverse range of families. The Lycaenidae family exhibited the highest density, accounting for 432 individuals, which underscores its dominance in the study area. The Noctuidae family followed with 242 individuals, demonstrating its substantial presence across the months, particularly dominating in March. The Pieridae family also showed a notable density with 150 individuals, with a significant peak observed in November. The Nymphalidae family contributed 85 individuals, displaying moderate densities across the winter season with slightly high in March. The Crambidae family was represented by 78 individuals also showed highest peak in March. The Papilionidae family had a lower density of 41 individuals showed least peak in January. The Erebidae family accounted 40 individuals while the Geometridae family had 24 individuals, both showing low densities. Families such as Gelechiidae, Scythrididae, Hesperiidae and Plutellidae had minimal representation with 8, 7, 2 and 2 individuals respectively, indicating their relatively lower abundance in the study area. (Figure 2).

Table 1: Diversity of Lepidopteran fauna on Rabi crops cultivated during Nov.2022 to March 2023 in an Agro-Ecosystem studied

S.No.	Zoological name	Common name	Crop Associations	Feeding Habits
Family Nymphalidae				
1.	*Danaus chrysippus*	The plain tiger	-	Pollinator
2.	*Junonia orithya*	The blue pansy	Sweet potato	Leaf Feeder
3.	*Junonia lemonias*	The lemon pansy	-	Pollinator
4.	*Vanessa cardui*	The painted lady	Chickpea, Lentil	Larvae feed on leaves, Pollinator
Family Papilionidae				
5.	*Papilio demoleus*	Lime swallowtail	Citrus plants	Pollinator as well as pest

6.	*Papilio polytes*	Common mormon	Citrus plants	Pollinator as well as pest
Family Pieridae				
7.	*Belenois aurota*	Pioneer white butterfly	-	Pollinator
8.	*Eurema andersoni*	One-spot Grass-yellow butterfly	-	Pollinator
9.	*Eurema hecabe*	Common Grass-yellow butterfly	-	Pollinator
10.	*Eurema brigitta*	Small grass yellow butterfly	-	Pollinator
11.	*Colotis amata*	Small salmon Arab butterfly	-	Pollinator
12.	*Catopsilia pyranthe*	The Mottled Emigrant butterfly	-	Pollinator
13.	*Catopsilia pomona*	Common emigrant butterfly	-	Pollinator
14.	*Pieris brassicae*	Cabbage butterfly	Mustard, Cabbage, Cauliflower, Radish	Larvae feed on leaves
Family: Lycaenidae				
15.	*Spindasis vulcanus*	Common silver line	-	Pollinator
16.	*Pseudozizeeria maha*	Pale grass blue	-	Pollinator
17.	*Leptotes plinius*	Zebra blue	-	Pollinator
18.	*Catochrysops Strabo*	Forget me not	Beans	Pest
19.	*Rapala manea*	Slate flash	-	Pollinator

20.	*Zizina otis*	Lesser grass blue butterfly	-	Pollinator
21.	*Zizeeria karsandra*	Dark Grass Blue butterfly	-	Pollinator
22.	*Euchrysops cnejus*	Gram blue butterfly	Black gram, Cowpea, Pea, Beans	Pest
23.	*Zizula hylax*	Pygmy Grass Blue butterfly	-	Pollinator
24.	*Anthene emolus*	Ciliate Blue butterfly	-	Pollinator
25.	*Chilades lajus*	Lime Blue butterfly	-	Pollinator
Family: Hesperiidae				
26.	*Suastus gremius*	Indian palm bob	-	Pollinator
Family: Noctuidae				
27.	*Heliothis uncta*	Bordered straw moth	Mung bean, Cowpea, Chickpea, Lentil	Pest
28.	*Heliothis peltigera*	Bordered straw moth	Mung bean, Cowpea, Chickpea, Lentil	Pest
29.	*Helicoverpa armigera*	Gram pod borer	Pigeonpea, Mung bean, Chickpea,Cowpea, Lentil, Barley, Beans, Chillies	Pest
30.	*Helicoverpa zea*	Corn earworm	Pigeonpea, Mung bean, Chickpea, Lentil, Mustard	Pest
31.	*Anticarsia irrorata*	Owl moth	Chickpea, Lentil	Pest

32.	*Agrotis ipsilon*	Greasy cutworm/ black cut worm	Wheat, Carrot, Potato, Cabbage, Cauliflower, Chillies	Larvae cut stems
33.	*Earias insulana*	Spiny bollworm or cotton spotted bollworm	Chickpea, Lentil, Cotton	Pest
34.	*Earias vitella*	Spotted bollworm	Chickpea, Lentil	Larvae feed on pods
35.	*Sesamia inferens*	Pink stem borer	Wheat	Pest
36.	*Spodoptera exigua*	Beet armyworm	Cow pea, Chickpea, Lentil, Mustard, Cabbage, Cauliflower, Onion, Chillies	Pest
37.	*Spodoptera mauritia*	Lawn armyworm	Suger-beet, Chickpea, Lentil, Mustard, Barley	Pest
38.	*Spodoptera frugiperda*	Fall army worm	Chickpea, Lentil, Mustard	Pest
39.	*Thysanoplusia orichalcea*	Semi looper	Cowpea, Cabbage, Chickpea, Lentil, Cauliflower, Radish, Potato	Pest
Family: Crambidae				
40.	*Haritalodes Derogata*	Leaf roller	Chickpea, Lentil	Pest
41.	*Leucinodes orbonalis*	Shoot borer	Cowpea, Pea, Potato, Chickpea, Lentil	Pest
42.	*Spoladea*	Beet web-worm moth	Spinach, Beetroot,	Pest

	recurvalis		Chickpea, Lentil	
43.	*Hellula undalis*	Cabbage web-worm	Cabbage,Cauliflower, Radish, Mustard	Pest
44.	*Diaphania indica*	Cucumber moth / cotton caterpillar	Chickpea, Lentil	Pest
45.	*Maruca testulalis*	Spotted pod borer	Pigeonpea, Chickpea, Cow pea, Beans, Lentil	Pest
Family: Erebidae				
46.	*Thyas coronata*	Yellow Underwing Moths	Chickpea, Lentil	Pest
47.	*Utetheisa pulchelloides*	Heliotrope moth	Chickpea, Lentil	Pest
48.	*Utetheisa pulchella*	Crimson-speckled flunkey or crimson-speckled moth	Chickpea, Lentil	Pest
49.	*Aloa lactinea*	Red costate tiger moth	Chickpea, Lentil	Pest
Family: Geometridae				
50.	*Traminda mundissima*	-	Chickpea, Lentil	Pest
Family: Scythrididae				
51.	*Eretmocera impectella*	-	Mustard	Pest
Family: Gelechiidae				
52.	*Pectinophora gossypiella*	Pink bollworm	Chickpea, Lentil	Larvae feed on pods and seeds

53.	*Tuta absoluta*	Tomato leafminer	Tomato	Pest
Family: Plutellidae				
54.	*Plutella xylostella*	Diamond back moth	Mustard, Cabbage, Cauliflower; Radish	Pest

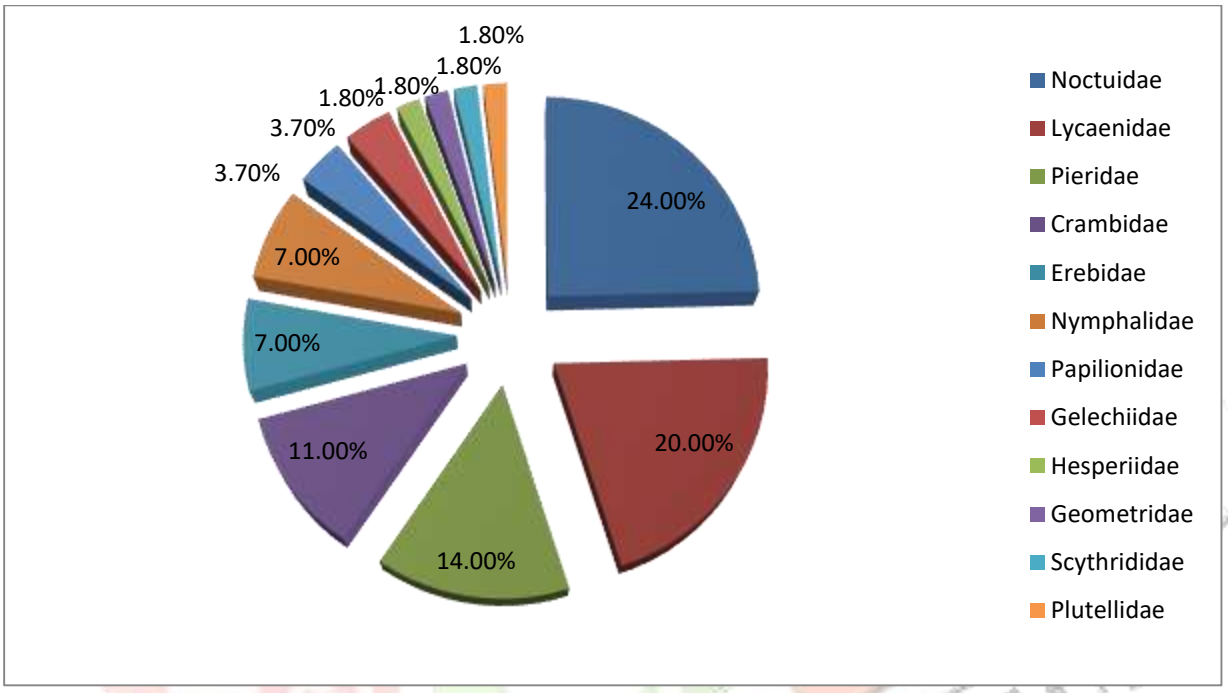

Figure 1: Diversity wise percentage composition of Lepidopteran families during the study period (November 2022- March 2023)

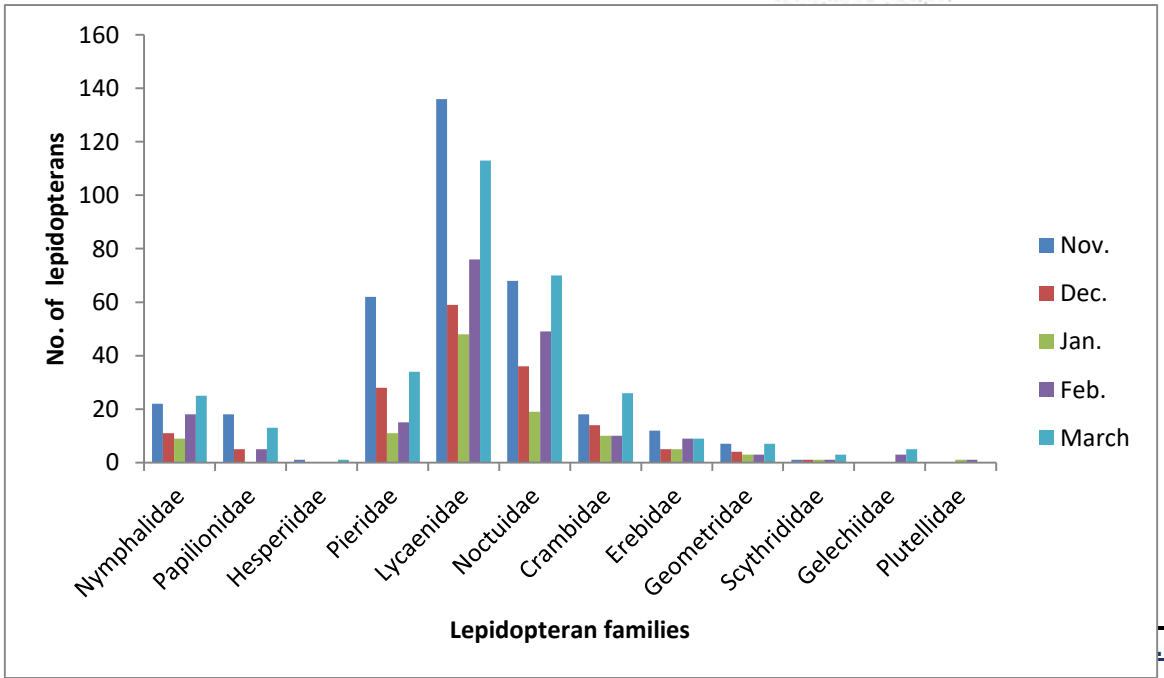

Figure 2: Month-wise density of Lepidopteran families during the study period (November 2022- March 2023)

Discussion:

The Shekhawati region of Rajasthan, India, presents a unique agro-ecosystem that harbors a diverse array of lepidopteran species. Recent research in this area has shed light on the importance of studying and understanding the diversity of these insects for conservation, agricultural practices, and ecological management strategies. Follett et al., 2020 emphasized a wide range of agro-ecosystems from around the world and the functions of various insects on a large number of crops.

In terms of diversity, the Noctuidae family is found to be most varied family. The nocturnal moth larvae of Noctuidae family are polyphagous, feeding on a variety of crops and cause serious damage to chilli, tomato, potato, cabbage, cucurbits, radish, carrot and leafy vegetables. In terms of density, Lycaenidae is found to be most dominant family. The Lycaenidae, or "blues", are a large family of small to medium-sized butterflies. Factors like habitat availability, host plant diversity, climate and lack of natural enemies could potentially contribute to high Lycaenidae densities in the studied region. Many Lycaenidae species have specialized relationships with host plants or ant species. Likewise, similar observations have been made by Prajapat et al., 2023 that revealed a rich diversity of butterflies in the Aravalli region of Rajasthan. Rani & Ahmed (2021) examined the seasonality and diversity of butterflies in Rajasthan's Sariska Tiger Reserve, while Savita & Trigunayat (2022) investigated the species richness, evenness, and diversity of the moth fauna in Jaipur, Rajasthan. The current study found remarkably similar outcomes.

Surveying nocturnal moths is best done with light trapping (Jonason et al.2014). Gehlot et al., 2021 have employed similar methodologies such as light trapping, sweep netting, and transect surveys to assess the abundance and diversity of butterflies and moths from urban region of Jodhpur, Rajasthan. All the above studies support the present observations.

In order to gain insight into the interactions between plants and pollinators, Layek et al.,2024 examined the spatial and temporal variations in richness, diversity, and abundance of floral visitors of curry plants (*Bergera koenigii L.*) The preference of certain species for specific host plants and the influence of landscape structure on species diversity and distribution studied by Seema &Srivastava 2012.

During the study period, the number of butterfly species increases throughout the winter, and their fluctuations in abundance are positively correlated with richness. Roy et al. (2001) also observed that very high temperatures had a negative impact on butterfly abundance.

Agrotis ipsilon, the black cutworm, is a well-known pest in all rabi crops . Lefroy (1904) and Thimmaiah et al. (1972)also reported *Agrotis ipsilon* as a damaging pest of many cultivated crops, including potatoes, wheat, cotton, tobacco, and gram which is also supported by Bindra & Singh (1970)and Singh & Sinha (1965).

Diamond Back moth *Plutella xylostella* mostly feeds on cabbage and cauliflower which is also documented by Abraham and Padmanabhan (1968) and Sachan & Gangwar (1980). *Heliothis armigera*, the pod borer, has been identified by Rawat et al. (1979) as a major pest of Gram in all of India. Zaz & Kushwaha (1983) recorded *S. litura* and *S. exigua* in cauliflower and cabbage crops. According to reports, S. exigua and S. litura were the dominating species at Bikaner in November (Progress Report ARSSW, 1998). During the present study also, this species was reckoned more during November month.

The spotted bollworm *Earias insulana* and *E. vitella* were collected from the agroecosystem during Rabi crop seasons when wheat and mustard were planted in fields.

Dhas (2007) reported that *Plusia orichalcea*, an uncommon variety, was present in all three crop seasons inside the agroecosystem. Many vegetables, including peas, cabbage, cauliflower, radish, potatoes, carrots, indigo, linseed, and others, are frequently infested with this parasite. It happens throughout India and occurs most frequently in the winter and spring. The present study also documented this.

Dhas (2007) collected a solitary till hawk moth, *Acherontia styx*, a rare species within the Sphingiidae family, from the agroecosystem over the course of three seasons. Roonwal (1982) also reported finding *A. styx* in the dry districts of Rajasthan which is also documented in the present study.

Despite being uncommon, reports of the "plain tiger," Danaus chrysippus, have been made in all three seasons and every month. The larvae of this common butterfly in India consume the leaves of the *Calotropis gigantea* and *Eruca sativa* (Nayar et al., 1998). Donahue (1962) and Roonwal (1982) have also recorded sightings of D. chrysippus in Rajasthan's Thar Desert.

According to Atwal and Dhaliwal (1999), *Pieries brassicae* is a severe pest of cabbage, cauliflower, and knoll-knoll plants. It can also attack radish, mustard, and other cruciferous plants. Bhardwaj (2009) reported the highest population of *V. cardui in* the month of November while lowest in the months of January and June. Martin (1993) observed *Utethesia* to also occasionally visit flowers. All the above studies support the present observations.

The presence of endemic species and the interaction between native and invasive species further highlight the importance of studying this specific area to contribute to the broader understanding of lepidopteran diversity.

Conclusion:

In an agro-ecosystem, the current study offers a thorough evaluation of the variety of lepidopterans in Rabi crops. The abundant variety of lepidopteran species suggests that the agro-ecosystem's soil nutrient content and compatible conditions, appropriate host plants, and meteorological factors like temperature and rainfall were ideal for the growth and development of lepidopterans during the research period. Understanding of lepidopteran diversity in agro-ecosystems can contribute to more effective conservation and management strategies that limit negative effects on the environment and economy while increasing crop yields.

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