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Diversity of arthropod fauna associated in Chilli ecosystem in Ri-Bhoi district of Meghalaya

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ABSTRACT

Chilli (*Capsicum annuum* L.) is an important spice and vegetable crop cultivated globally. However, its productivity and yield are often hindered by insect pest attacks. From March to June 2024, a study was conducted to assess the insect diversity in the Chilli ecosystem across three locations in the Ri-bhoi district of Meghalaya: Umsning, Nongpoh, and Bhoirymbong. The study identified 27 species of insect pests across 6 orders and 15 families. Among these pests, aphids, *Aphis gossypii* and *Myzus persicae*, were the most prevalent, with relative abundances of 30.19 % and 27.68 %, respectively. Other pests included the thrips, *Scirtothrips dorsalis* (8.94 %), whitefly *Bemisia tabaci* (3.71 %), fruit borer, *Helicoverpa armigera* (3.45 %), and the mealybug, *Ferrisia virgata* (2.82 %). Analysis of correlations between major insect pests (aphids, whiteflies, thrips, and fruit borers) and weather parameters revealed significant positive correlations with maximum temperature ($r=0.196$) and relative humidity ($r=0.355$) during the survey period. In diversity studies, both Simpson's index and Shannon-Weiner's index indicated that the species were highly diverse and evenly distributed in the community. Eleven species of natural enemies were recorded, belonging to 4 orders and 5 families, with *Coccinella septempunctata* being the most abundant at 16.66 %. The study also identified eight species of pollinators, honeybees (*Apis* spp.) being the most prevalent at 21 % and 13 species of visitors were recorded among which Ground bug (*Lygaeus equestris*) recorded the highest relative abundance (17.77 %).

Keywords: Correlation, aphids, thrips, relative abundance, Simpson's index, Shannon-Weiner's index.

1. Introduction

Chilli (*Capsicum annuum* L.), a significant spice and vegetable crop from the Solanaceae family, is believed to have originated in Mexico. Globally, Chilli production reached approximately 4.25 million tonnes across 1.5 million hectares areas (FAO, 2019). India leads the world in Chilli production, followed by China and Pakistan. In India, Chilli is cultivated on an area of 7.32 lakh hectares, yielding 1.7 million tonnes with a productivity rate of 2,716 kg/ha (AMIC, 2021). Andhra Pradesh is the leading producer in India with an annual production of 8.36 lakh tonnes. In the North Eastern states, Nagaland record the highest

productivity at 6.69 tonnes per hectare, followed by Arunachal Pradesh, Mizoram, Assam, and Meghalaya (NHB, 2017). In Meghalaya, Chilli is grown in an area of 2,320 hectares, producing 2,346 metric tonnes with a productivity of 1,011 kg/ha (GoM, 2018). Despite India's leading role in global Chilli production, its productivity and output are hampered by factors such as adverse weather conditions, poor seed quality, and pest and disease pressures. Over 39 genera and 51 species of pests have been reported affecting Chilli crops both in the field and during storage (Hosamani *et al.*, 2005). In the North East, major insect pests affecting Chilli crops includes aphids (*Aphis gossypii*, *Myzus persicae*), whiteflies (*Bemisia tabaci*), thrips (*Scirtothrips dorsalis*), mites (*Polyphagotarsonemus latus*), and fruit borers (*Helicoverpa armigera*) (Thanjam *et al.*, 2020). Aphids and thrips can cause up to 50 % damage in Chilli production (Das, 2013), Chilli mites can result in yield losses of up to 30 % (Rai *et al.*, 2014) and fruit borer upto 30-40 % (Rashid *et al.*, 2022). Understanding pest diversity, distribution, and peak occurrence is vital for enhancing pest management strategies and reducing reliance on highly toxic chemical insecticides. Hence, this study was conducted to explore arthropod diversity in the Ri-Bhoi district of Meghalaya.

2. Materials and Method

2.1 Survey areas

Survey was conducted in three different blocks *viz.* Umsning, Nongpoh and Bhoirymbong under the Ri-Bhoi district of Meghalaya. Each of these blocks includes two villages and from each village two fields were selected. In Umsning block the insect specimens were collected from two villages, Umtrew and Umbang while in Nongpoh the two villages included in the survey were Umta and Kharpati and in Bhoirymbong, Kyrdem and Mawkyrdep villages were selected for collection of arthropod fauna within the Chilli ecosystem.

2.2 Monitoring of insect pests and natural enemies

Insects and natural enemies specimens were collected during the month of March-June, 2024 with the help of different insects collection techniques: Pheromone traps, incorporating the sex pheromone "Helilure" were utilized to capture male insects of fruit borers. Yellow sticky traps were employed for monitoring aphids, whiteflies, and leaf miner adults. Blue sticky traps were utilized for monitoring thrips. Handpicking was a hands-on method employed for the collection of certain coleopteran beetles such as Coccinellidae, Chrysomelidae, and Curculionidae (Kumar *et al.*, 2016).

The observation on per cent fruit infestation caused by *Helicoverpa armigera* was recorded during the survey by counting healthy and damaged fruits on 10 randomly selected plants of each villages and the percent fruit borer infestation was computed as follows:

$$\text{Percent fruit infestation} = \frac{\text{Number of fruit infested per plant}}{\text{Total number of fruit per plant}} \times 100$$

2.3 Identification of insects:

Identification of insects was carried out to the lowest possible taxon, by comparing specimens with those available in the Entomology Laboratory, CPGS-AS, and also using insect voucher specimens, manual keys, monographs and descriptions.

2.4 Correlation of major insect pests with weather parameters:

The weekly incidence of the major insect pests associated with Chilli from the month of March-June, 2024 was correlated with the weekly meteorological data collected from the Division of Agricultural Engineering, ICAR Research Complex for North Eastern Hill region, Umiam, Meghalaya.

2.5 Statistical analysis:

The mean populations for each insect and natural enemies were calculated in Microsoft Excel. Percentage of number of species encountered was calculated order-wise to find out relative abundance. Species dominance, richness and evenness were calculated using Simpson's index (1-D), Shannon-Weiner Diversity index (H) and Pielou's evenness index ($E=H'/\ln S$) based on the formula mentioned below:

Species Dominance Index

Simpson's index (Simpson, 1949)

$$D_s = 1 - \sum (n_i (n_i - 1)) / (N(N-1))$$

where, D_s = Simpson's index of diversity

n_i = total number of individuals of the particular species

N = total number of individuals of all species

Species Richness Index:

Shannon-Weiner diversity index (Batten, 1976)

$$H' = \sum p_i \ln p_i$$

where, p_i = the proportion of individuals in the i^{th} species

Species Evenness Index:

Pielou's evenness index (Pielou, 1966)

$$E = H' / \ln S$$

where, H' = Shannon-Weiner diversity index

S = total number of species in the sample

To study the influence of weather parameters on the incidence and population of major insect pests of Chilli, correlation coefficients (r) were calculated by using formula given by Pearson (1973).

Correlation co-efficient (r): -

$$r_{XY} = \frac{N(XY) - (\sum X)(\sum Y)}{\sqrt{[N \sum X^2 - (\sum X)^2][N \sum Y^2 - (\sum Y)^2]}}$$

Where, x is an independent variable, y is a dependent variable and n is the sample size.

Data Availability Statement

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

3. Results and discussion

3.1 Insect diversity in Chilli crop eco-system

The diversity of insect species in Chilli ecosystem was studied during March-June, 2024 across three different locations in the Ri-bhoi district of Meghalaya viz., Umsning, Nongpoh, and Bhoirymbong. A total of 59 species of insects were recorded, which included 27 insect pests,

11 natural enemies, 8 pollinators and 13 visitors belonging to 10 orders and 37 families. The order Coleoptera recorded the highest number of species (18) followed by Hemiptera (13), Diptera (7), Lepidoptera (6), Orthoptera (6), Hymenoptera (4), Araneae (2), Thysanoptera (1), Odonata (1) and Mantodea (1) (Table 1). Kaur and Sangha (2016) reported similar findings, recording 41 arthropod species associated with the Chilli crop, including 14 pests, 14 natural enemies, 12 casual visitors and 1 pollinator. Their study found Coleoptera to be the dominant order (26.83%), followed by Lepidoptera (14.63%), Hemiptera, Hymenoptera, and Orthoptera (each at 9.76%). Diptera, Isoptera, and Odonata each constituted 4.88%, while Dictyoptera, Neuroptera, and Thysanoptera each accounted for 2.22 %, and other unidentified species and spiders made up 2.42 %. Bhatt and Karnatak (2020) also studied the diversity of arthropod fauna in Chilli crops, identifying 11 orders. They found that the highest number of arthropods, including both insect pests and natural enemies, belonged to the order Coleoptera (9 species), followed by Hemiptera (4 species) and Lepidoptera (4 species).

3.2 Diversity indices

Diversity indices were recorded from the first week of March (9th SMW) to the last week of June (25th SMW). Simpson's Index (1-D) indicated the peak diversity in the month of May (0.87). The Shannon-Weiner Diversity Index (H) ranged from a minimum of 2.52 in March to a maximum of 2.81 in May. Pielou's Evenness Index ($E = H'/\ln S$) revealed that species distribution was least even in March (0.24) and most even in May (0.33) (Table 2, Fig 2). Bora *et al.* (2020) determined the diversity indices of Chilli crop, the obtained values of Simpson's index ranged from 1.55 to 1.38, the Shannon index ranged from 1.18 to 1.54 and the Pielou's evenness index ranged from 0.69 to 0.79 during April to May. These values indicated a relatively high level of species diversity and a moderately even distribution of individuals among species during this period. Kaur and Sangha (2016) reported that the highest values of Simpson's index were observed in April (5.88), whereas the Shannon-Weiner index indicated peak diversity in May (1.76). Conversely, both indices recorded the lowest diversity in March, with Simpson's index at 2.33 and the Shannon-Weiner index at 0.88 which may be due to seasonal variations. These findings are comparable to the findings from the present study.

3.3 Relative abundance of insect pests recorded in Chilli ecosystem

During the survey period from March-June, 2024 a total of 27 species of insect pests were recorded which belonged to 6 orders and 15 families. Species richness was found to be maximum in the order Hemiptera with 12 species followed by Coleoptera (6), Orthoptera (3), Lepidoptera (3), Diptera (2), and Thysanoptera (1). The most abundant order was Hemiptera with 73.56 % relative abundance followed by Thysanoptera (8.94%), Coleoptera (7.52 %), Lepidoptera (5.96 %), Orthoptera (3.49 %) and Diptera (0.50 %) (Table 3, Fig 3 and 4)

During these months, aphids, *Aphis gossypii* and *Myzus persicae* recorded the highest relative abundance of 30.19 % and 27.68 % respectively. This was followed by thrips, *Scirtothrips dorsalis* (8.94 %), whitefly, *Bemisia tabaci* (3.71 %), fruit borer, *Helicoverpa armigera* (3.45 %) and mealybug, *Ferrisia virgata* (2.82 %). The results of the study were in conformity with Chintkuntlawar *et al.* (2015) who recorded 6 species of insect pests viz., aphids, thrips, whitefly, jassids, gram pod borer and tobacco caterpillar in Chilli crop which constituted 3 species of Hemiptera (34 %), 2 species of Lepidoptera (22 %) and 1 species of Thysanoptera (11 %). Yadav *et al.* (2017) recorded five insect species viz., thrips (*Scirtothrips dorsalis*), aphid (*Aphis gossypii*), whitefly (*Bemisia tabaci*), fruit borer (*Helicoverpa armigera*) and mite (*Polyphagotarsonemus latus*) and majority of the insects were found to be active from vegetative to fruiting stages of crop. The peak population of thrips (*Scirtothrips dorsalis*),

whiteflies (*Bemisia tabaci*) and fruit borer (*Helicoverpa armigera*) were observed on Chilli crop from mid of April to mid of May with 45.86, 6.28 and 1.56 insect/plant. Similarly, this finding was supported by Mannan *et al.* (2020) who reported thrips, fruit borer and tobacco caterpillars as major insect pests of Chilli collected from the surveyed areas.

3.4 Seasonal incidence of major insect pests in Chilli ecosystem.

The incidence of major insect pests of Chilli viz., aphids- *Aphis gossypii*, thrips- *Scirtothrips dorsalis*, whiteflies- *Bemisia tabaci* and fruit borer (*Helicoverpa armigera*) were recorded during the survey period from March-June, 2024 (Table 4, Fig 5). The incidence of sucking pests was observed from 9th SMW recording an average of (12.4 individuals) and reached a peak at 16th SMW (38.4 individuals). The incidence of fruit borer was observed from 16th SMW recording an average of (1.7 individuals) and reached a peak at 23rd SMW (7.1 individuals). These findings were contradicted by Gupta *et al.* (2016) who observed peak population of thrips (6.60 and 6.93/three leaves) in the last week of April in 2014 and 2015. Aphid population peaked at 2.80 and 3.07/three leaves in the first week of May in 2014 and the last week of April in 2015. Whitefly reached its peak population (5.80 and 7.27/three leaves) in the third week of April in 2014 and the last week of April in 2015. This was found to be true and in line with our findings. Band *et al.* (2019) recorded 3 insect pests infesting Chilli crop viz., *Aphis gossypii*, *Scirtothrips dorsalis* and *Helicoverpa armigera*. The first appearances of aphids were observed when the crop was about 39 days old after transplanting *i.e.*, vegetative stage and remained active upto the third week of February *i.e.*, during 1-7th standard meteorological week. First appearance of Chilli thrips were observed when the crop was about 109 days after transplanting *i.e.*, vegetative stage and remained active upto the fourth week of May *i.e.*, during 11-12th standard meteorological week. First appearance of fruit borer larvae was observed when the crop was about 114 days after transplanting *i.e.*, the maturity stage and remained active up to the fourth week of May *i.e.*, 12-21st standard meteorological week.

3.5 Correlation of weather parameters with incidence of major insect pests in Chilli ecosystem.

The correlation study of major insect pests (aphids-*Aphis gossypii*, thrips-*Scirtothrips dorsalis*, whiteflies-*Bemisia tabaci*, and fruit borer- *Helicoverpa armigera*) with weather parameters revealed a significant positive correlation between pest populations and maximum temperature ($r = 0.345$). Non-significant positive correlations were observed with minimum temperature, minimum relative humidity, and rainfall ($r = 0.738$, $r = 0.688$, and $r = 0.605$). These results are in close conformity with those of Havanoor and Rafee (2018) who reported that maximum temperature had significant positive correlation with major insect pests of Chilli. Saini *et al.* (2017) reported that whiteflies exhibited non-significant positive correlation with minimum relative humidity and rainfall which might be due to seasonal and geographical variations. This was in accordance with the work of Matra *et al.* (2023) who stated that aphids had non-significant negative correlations with rainfall ($r = -0.114$) and morning humidity ($r = -0.010$), but positive correlations with maximum temperature ($r = 0.496$), minimum temperature ($r = 0.467$), evening humidity ($r = 0.285$). Thrips showed a significant positive correlation with morning humidity ($r = 0.586$) and non-significant correlations with other weather parameters: rainfall ($r = -0.098$), maximum temperature ($r = 0.159$), minimum temperature ($r = 0.360$), evening humidity ($r = 0.501$) whereas, whiteflies had non-significant positive correlations with rainfall ($r = 0.059$), maximum temperature ($r = 0.003$), minimum temperature ($r = 0.343$), morning humidity ($r = 0.513$) and evening humidity ($r = 0.509$).

3.6 Population of major insect pests recorded in different locations of survey areas viz., Umsning, Nongpoh and Bhoirymbong

The results presented in (Table 5) revealed that the highest number of *Aphis gossypii* was observed in Umtrew (475) and Umbang village (320), with a total of 795 individuals. The maximum number of *Myzus persicae* was found in Kyrдем (340) and Mawkyrdep village (265), with a total of 605 individuals. *Scirtothrips dorsalis* was most abundant in Umtrew (120) and Umbang villages (128), with a total of 248 individuals. *Bemisia tabaci* was most prevalent in Kyrдем (55) and Mawkyrdep villages (56), with a total of 111 individuals. The highest number of *Helicoverpa armigera* was recorded in Umta (50) and Kharpati villages (40), with a total of 90 individuals (Table 5). Similarly, Kumar *et al.* (2021) assessed insect pests in Chilli crops during the Kharif season across Rewari and Gurugram districts in Haryana. In Rewari, thrips populations ranged from 7.98 to 13.06 thrips/plant, while aphid populations ranged from 21.38 to 33.44 aphids/plant, with varying densities across different villages. In Gurugram, thrips counts varied from 7.26 to 11.96 thrips/plant, and aphid counts ranged from 19.49 to 31.49 aphids/plant, depending on the village surveyed.

3.7 Per cent (%) fruit infestation of *Helicoverpa armigera* recorded in different locations viz., Umsning, Nongpoh and Bhoirymbong

The highest per cent fruit infestation was recorded from Umta (11.34 %) and Kharpati (8.74 %) villages under Nongpoh block (20.08 %) fruit infestation followed by Umtrew (10.43 %) and Umbang (8.67 %) villages under the Umsning block with a total of 19.1 % fruit infestation and lowest per cent fruit infestation was recorded from Kyrдем (9.32 %) and Mawkyrdep (7.98 %) villages with a total of 17.30 % fruit infestation in Bhoirymbong block (Table 6).

3.8 Relative abundance of natural enemies of insect pests

Eleven natural enemies were recorded during the month of March-June, 2024. Among the natural enemies, *Coccinella septempunctata* recorded the highest relative abundance (16.66 %), *Coccinella transversalis* (15.43 %), *Henosepilachna vigintiotopunctata* (12.96 %), *Oenopia sexareata* (11.11 %), *Micraspis discolor* (10.09 %), *Coelophora inaequalis* (8.64 %), *Brumoides suturalis* (6.17 %) followed 1 species of dragonfly, *Diplacodes trivialis* (6.17 %), preying mantids, *Mantis religiosa* (4.93 %) and 2 species of spider viz., *Oxyopes* spp. (4.32 %) and *Araneus marmoroides* (3.70 %) respectively (Table 7, Fig 6). A similar report was given by Thanjam *et al.* (2020) who recorded a total of 205 coccinellids, representing 19 species from 11 genera which were observed preying on sucking pests of King Chilli. *Coccinella transversalis* had the highest numerical presence (40 individuals), followed by *Menochilus sexmaculatus* (38 individuals) and *Micraspis discolor* (34 individuals), while *Platynaspis* spp. had the lowest count (1 individual). In terms of relative abundance, *Coccinella transversalis* dominated with 19.51 %, followed by *Menochilus sexmaculatus* (18.54 %), *Micraspis discolor* (16.59 %), *Brumoides suturalis* (7.32 %), *Coelophora bissellata* (5.85 %), and *Coccinella septempunctata* (4.88 %). Kaur and Sangha (2016) reported 14 natural enemies from the Chilli ecosystem, among which dominant species included coccinellids (*Coccinella septempunctata*, *Menochilus sexmaculatus*, *Brumoides suturalis*) and spiders.

3.9 Relative abundance of pollinators in Chilli ecosystem

Eight species of pollinators were recorded, among which Hymenoptera was the predominant order with 4 species of pollinators viz., honeybee (*Apis* spp.) recorded the highest relative abundance of 21%, followed by paper wasp, *Polistes* spp. (18%), Scolid wasp, *Scolia dubia* (11 %), Blue flower wasp, *Austroscolia soror* (9 %). The other pollinators were Hoverfly, *Episyrphus viridaureus* (15 %), Marmalade hoverfly, *Episyrphus balteatus* (11 %), Handmaiden moth, *Syntomoides imaon* (8 %) and Pansy butterfly, *Junonia lemonias* (7 %) (Table 7, Fig 7). This was in accordance with the work of Ellahi *et al.* (2017) who recorded two species of pollinators viz., butterflies and honeybees in Chilli ecosystem. Thangjam *et al.*

(2021) also reported four species of Syrphid fly viz., *Episyrphus viridaureus*, *Ischiodon scutellaris*, *Lathrophthalmus arvorum*, *Serratoparagus crenulatus*. They reported the dual role of syrphids as pollinators as well as predators of aphids in Chilli.

3.10 Relative abundance of visitors in Chilli ecosystem

During the study, thirteen insect species were identified as casual visitors. The ground bug (*Lygaeus equestris*) was the most abundant (17.77 %), followed by bush cricket, *Elimaea fallax* (11.11 %), *Homoeoxipha lycoides* (8.88 %) and *Neoconocephalus palustris* (6.66 %). Other visitors included the jewel beetle (*Chrysochoroa buqueti*), blister beetle (*Mylabris phalerata*), crinium borer (*Brithys crini*), click beetle (*Hemiops flava*), soldier fly (*Ptecticus trivittatus*), and blow fly (*Lucilia* spp.) each at 6.66 %, while the tortoise beetle (*Dorynota* spp.), longhorned beetle (*Nupserha fricator*), and crane fly (*Nephrotoma virgata*) each recorded 4.44 % relative abundance (Table 7, Fig 8). The study was in conformity with those of Buragohain *et al.* (2020) who reported 12 species of insects as casual visitors of Chilli. Out of these, 6 species belonged to Hymenoptera (*Ceratina hieroglyphica*, *Occophylla smaragdina*, *Tapinoma* spp., *Polyrachis* spp., *Technomyrmex albipes* and *Dolichoderus* spp.), 3 species belonged to Hemiptera (*Cletus punctiger*, *Dysdercus koenigii* and *Leptoglossus phyllopus*), whereas one each from Diptera, Blattodea and Orthoptera, i.e., *Chrysomya megacephala*, *Blattella* spp. and *Trilophidia annulata*, respectively.

Conclusion:

The study found that the Chilli ecosystem has moderate to high biodiversity, among which major pests included *Aphis gossypii*, *Myzus persicae*, *Scirtothrips dorsalis*, *Bemisia tabaci*, and *Helicoverpa armigera*. Species diversity was highest in May, with significant variation in pest abundance throughout the study period. *Coccinella septempunctata* and honeybees (*Apis* spp.) were the most prevalent natural enemies and pollinators, respectively. A significant positive correlation was observed between pest populations and maximum temperature, but no significant association were found with minimum temperature, humidity or rainfall.

Data Availability:

The data generated or analysed during this study are included in this published article

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Author Contributions

S.B. conducted field surveys, insect collection, laboratory identification, and drafted the manuscript. M.P. supervised the research project and edited the manuscript. K.N., T.R., and R.K.P. assisted in experimental methodologies, statistical analyses, and manuscript reviewing. J.G. assisted in field sampling and data compilation.

Competing Interests

The authors declare no competing interests.

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Figure legends



Fig1 : Installation of Yellow sticky and blue sticky traps in survey areas

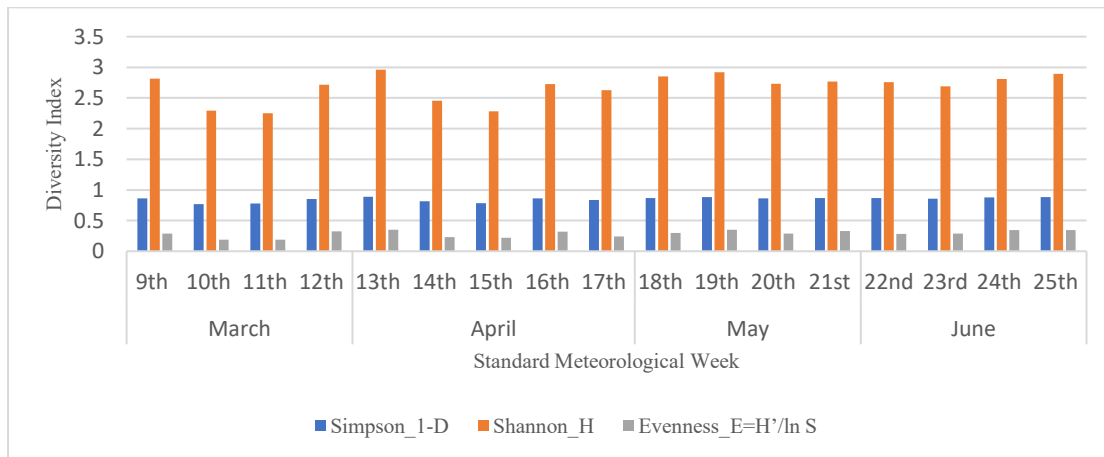


Fig 2. Diversity indices of insects in Chilli ecosystem recorded from March-June, 2024

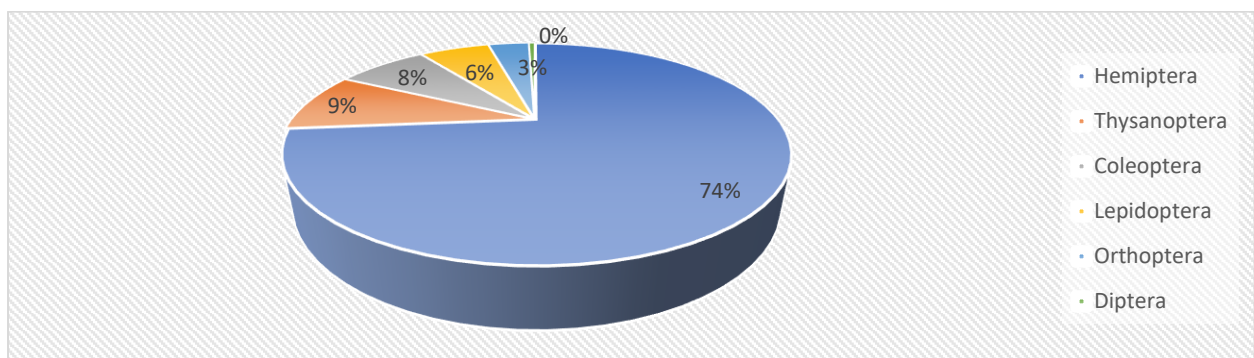


Fig 3: Order wise distribution of relative abundance of insect pests recorded during survey in Chilli ecosystem

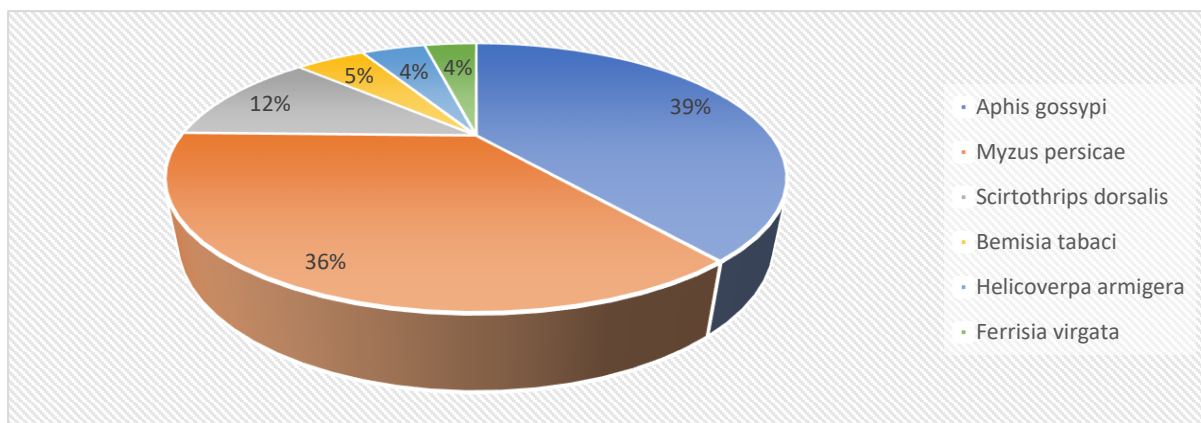


Fig 4: Relative abundance of major insect pests recorded during survey in Chilli ecosystem



Fig 5: Seasonal incidence of major sucking pests and fruit borer recorded in Chilli ecosystem from March-June, 2024

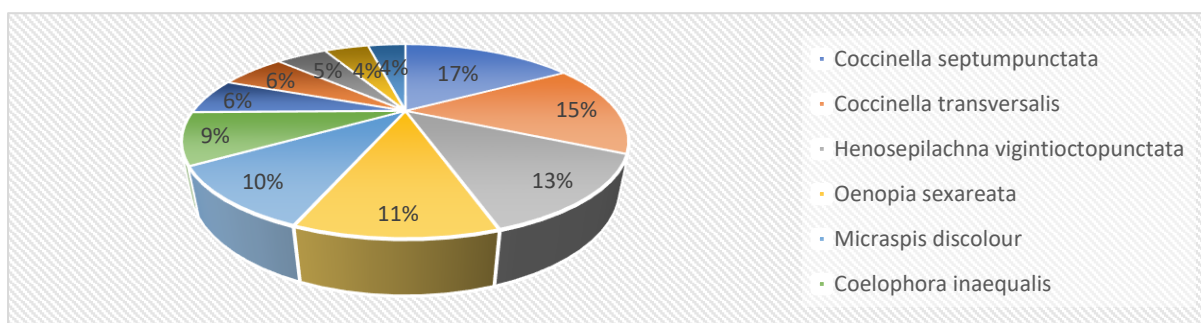


Fig 6: Relative abundance of natural enemies recorded during survey in Chilli ecosystem

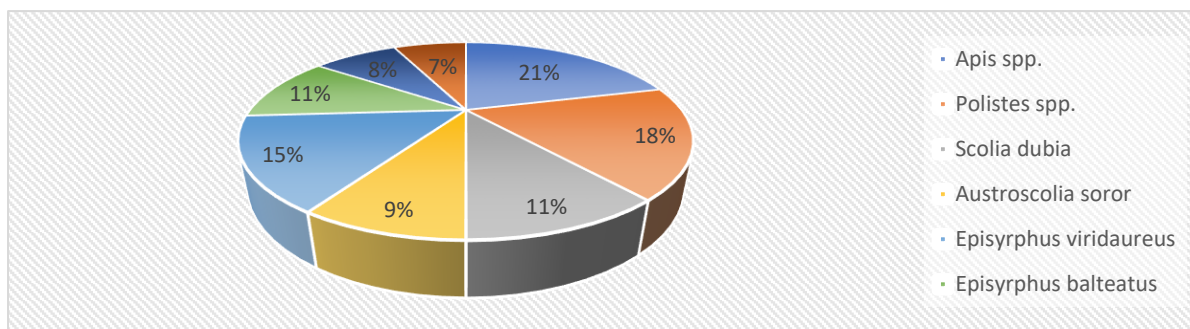


Fig 7: Relative abundance of pollinators recorded during survey in Chilli ecosystem

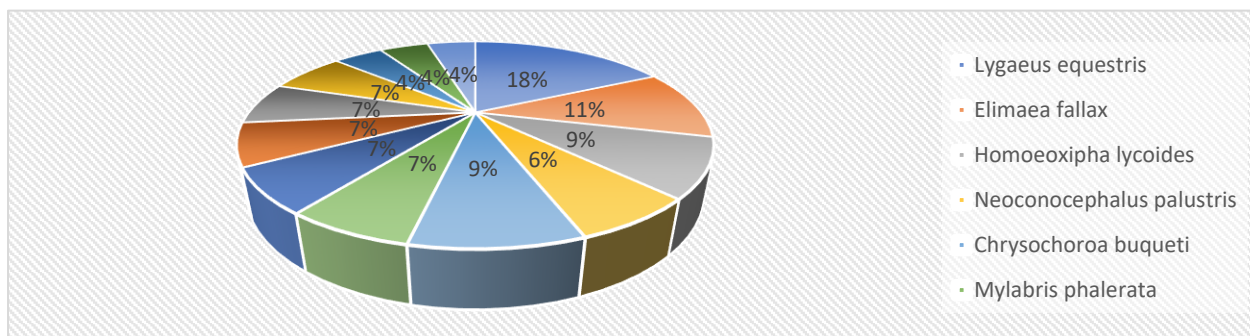


Fig 8: Relative abundance of visitors recorded during survey in Chilli ecosystem

Table 1: Diversity of hexapods/Insecta recorded in Chilli ecosystem during the survey period from March-June, 2024

Sl. No.	Common name	Scientific name	Family	Order	No. of individuals	Grand total
1.	Aphids	<i>Aphis gossypii</i>	Aphididae	Hemiptera	1925	4700
2.		<i>Myzus persicae</i>	Aphididae		1765	
3.	Whitefly	<i>Bemisia tabaci</i>	Aleyrodidae		237	
4.	Shield bug	<i>Eurydema dominulus</i>	Pentatomidae		85	
5.		<i>Eurydema ornate</i>	Pentatomidae		85	
6.		<i>Eurydema oleracea</i>	Pentatomidae		65	
7.	Mealybug	<i>Ferrisia virgata</i>	Pseudococcidae		180	
8.	Planthopper	<i>Omolicna</i> spp.	Delphacidae		85	
9.	Coreid bug	<i>Homoeocerus</i> spp.	Coreidae		80	
10.	Leafhopper	<i>Neocenchrea heidemanni</i>	Cicadellidae		78	
11.	Red cotton bug	<i>Dysdercus cingulatus</i>	Pyrhcoridae		61	
12.	Red mirid bug	<i>Hyalopeplus vitripennis</i>	Miridae		44	
13.	Ground bug	<i>Lygaeus equestris</i>	Lygaeidae		10	
14.	Flea beetle	<i>Phyllotreta vittula</i>	Chrysomelidae	Coleoptera	158	681
15.		<i>Aphthona flava</i>	Chrysomelidae		106	
16.	Pale striped flea beetle	<i>Systema blenda</i>	Chrysomelidae		62	
17.	Red pumpkin beetle	<i>Aulacophora femoralis</i>	Chrysomelidae		56	
18.	White spotted beetle	<i>Monolepta signata</i>	Chrysomelidae		54	
19.	Case bearing leaf beetle	<i>Chrysomela populi</i>	Chrysomelidae		44	
20.	Click beetle	<i>Hemiops flava</i>	Elateridae		15	
21.	Tortoise beetle	<i>Dorynota</i> spp.	Chrysomelidae		20	
22.	Jewel beetle	<i>Chrysochorea buqueti</i>	Buprestidae		15	

23.	Blister beetle	<i>Mylabris phalerata</i>	Meloidae		11	
24.	Longhorned beetle	<i>Nupserha fricator</i>	Cerambycidae		9	
25.	Lady bird beetle	<i>Coccinella septumpunctata</i>	Coccinellidae		27	
26.		<i>Coccinella transversalis</i>	Coccinellidae		16	
27.		<i>Henosepilachna vigintioctopunctata</i>	Coccinellidae		25	
28.		<i>Oenopia sexareata</i>	Coccinellidae		10	
29.		<i>Micraspis discolour</i>	Coccinellidae		14	
30.		<i>Coelophora inaequalis</i>	Coccinellidae		21	
31.		<i>Brumoides saturalis</i>	Coccinellidae		18	
32.	Thrips	<i>Scirtothrips dorsalis</i>	Thripidae	Thysanoptera	570	570
33.	Fruit borer	<i>Helicoverpa armigera</i>	Noctuidae	Lepidoptera	220	400
34.	Tobacco caterpillar	<i>Spodoptera litura</i>	Noctuidae		135	
35.	Black hairy caterpillar	<i>Estigmene lactinea</i>	Arctiidae		25	
36.	Crinum borer	<i>Brithys crini</i>	Noctuidae		5	
37.	Handmaiden moth	<i>Syntomoides imaon</i>	Erebidae		8	
38.	Pansy butterfly	<i>Junonia lemonias</i>	Nymphalidae		7	
39.	Bush Cricket	<i>Elimaea fallax</i>	Tettigoniidae	Orthoptera	7	247
40.		<i>Homoeoxipha lycoides</i>	Gryllidae		8	
41.		<i>Neoconocephalus palustris</i>	Tettigoniidae		9	
42.	Rice grasshopper	<i>Oxya fuscovittata</i>	Acrididae		65	
43.		<i>Oxya chinensis</i>	Acrididae		83	
44.	Slant faced grasshopper	<i>Mermiria bivittata</i>	Acrididae		75	
45.	Melon fruit fly	<i>Dacus persicus</i>	Tephritidae	Diptera	18	79
46.		<i>Bactrocera cucurbitae</i>	Tephritidae		14	
47.	Blow fly	<i>Lucilia</i> spp.	Calliphoridae		8	
48.	Crane fly	<i>Nephrotoma virgata</i>	Tipulidae		7	
49.	Soldier fly	<i>Ptecticus trivittatus</i>	Stratiomyidae		6	
50.	Hoverfly	<i>Episyrphus viridaureus</i>	Syrphidae		15	
51.		<i>Episyrphus balteatus</i>	Syrphidae		11	
52.	Honeybee	<i>Apis</i> spp.	Apidae	Hymenoptera	21	59
53.	Paper wasp	<i>Polistes</i> spp.	Vespidae		18	
54.	Scolid wasp	<i>Scolia dubia</i>	Scoliidae		11	
55.	Blue flower wasp	<i>Austroscolia soror</i>	Scoliidae		9	
56.	Spider	<i>Oxyopes</i> spp.	Oxyopidae	Araneae	10	18
57.		<i>Araneus marmoroides</i>	Araneidae		8	
58.	Dragonfly	<i>Diplacodes trivialis</i>	Libellulidae	Odonata	7	7
59.	Preying mantids	<i>Mantis religiosa</i>	Mantidae	Mantodea	6	6
	Grand total				6,829	

Months (March-June, 2024)	March	April	May	June
Total no. of insect species recorded	6,829			
No. of orders	10			
No. of families	37			
Species Dominance index (Simpson's index)	0.81	0.83	0.87	0.86

Species Richness index (Shannon index)	2.52	2.61	2.81	2.78
Species Evenness index (Pielou's evenness index)	0.24	0.27	0.33	0.31

Table 2: Diversity indices of insects in Chilli ecosystem recorded from March-June, 2024

Table 3: Relative abundance of insect pests recorded in Chilli ecosystem during the survey period from March-June, 2024

Sl. No.	Common name	Scientific name	Family	Order	No. of individuals	Average relative abundance (%)
1.	Aphids	<i>Aphis gossypi</i>	Aphididae	Hemiptera	1925	30.19
2.		<i>Myzus persicae</i>	Aphididae		1765	27.68
3.	Whitefly	<i>Bemisia tabaci</i>	Aleyrodidae		237	3.71
4.	Shield bug	<i>Eurydema dominulus</i>	Pentatomidae		85	1.33
5.		<i>Eurydema ornata</i>	Pentatomidae		85	1.33
6.		<i>Eurydema oleracea</i>	Pentatomidae		65	1.01
7.	Mealybug	<i>Ferrisia virgata</i>	Pseudococcidae		180	2.82
8.	Planthopper	<i>Omolicna</i> spp.	Delphacidae		85	1.33
9.	Coreid bug	<i>Homoeocerus</i> spp.	Coreidae		80	1.25
10.	Leafhopper	<i>Neocenchrea heidemanni</i>	Cicadellidae		78	1.22
11.	Red cotton bug	<i>Dysdercus cingulatus</i>	Pyrrhocoridae		61	0.95
12.	Red mirid bug	<i>Hyalopeplus vitripennis</i>	Miridae		44	0.69
	Total				4690	73.56
13.	Thrips	<i>Scirtothrips dorsalis</i>	Thripidae	Thysanoptera	570	8.94
14.	Flea beetle	<i>Phyllotreta vittula</i>	Chrysomelidae	Coleoptera	158	2.47
15.		<i>Aphthona flava</i>	Chrysomelidae		106	1.666
16.	Pale striped flea beetle	<i>Systema blenda</i>	Chrysomelidae		62	0.97
17.	Red pumpkin beetle	<i>Aulacophora femoralis</i>	Chrysomelidae		56	0.87
18.	White spotted beetle	<i>Monolepta signata</i>	Chrysomelidae		54	0.84
19.	Case bearing leaf beetle	<i>Chrysomela populi</i>	Chrysomelidae		44	0.69
	Total				480	7.52
20.	Fruit borer	<i>Helicoverpa armigera</i>	Noctuidae	Lepidoptera	220	3.45
21.	Tobacco caterpillar	<i>Spodoptera litura</i>	Noctuidae		135	2.11
22.	Black hairy caterpillar	<i>Estigmene lactinea</i>	Arctiidae		25	0.39
	Total				380	5.96
23.	Rice grasshopper	<i>Oxya fuscovittata</i>	Acrididae	Orthoptera	65	1.01
24.		<i>Oxya chinensis</i>	Acrididae		83	1.3
25.	Slant faced grasshopper	<i>Mermiria bivitatta</i>	Acrididae		75	1.17
	Total				223	3.49
26.	Melon fruit fly	<i>Dacus persicus</i>	Tephritidae	Diptera	18	0.28
27.		<i>Bactrocera cucurbitae</i>	Tephritidae		14	0.21
	Total				32	0.50

Table 4: Seasonal incidence of major insect pests of Chilli recorded during the survey period from March-June, 2024

Standard Meteorological Week	Max T (°C)	Min T (°C)	Max RH (%)	Min RH (%)	Rainfall (mm)	Mean population of sucking pests	Mean population of fruit borer
9	22.4	10.2	88.8	58.4	0.1	12.4	0
10	25.2	10	87.1	51.9	0	15.1	0
11	27.3	14.2	85	51.6	0	24.6	0
12	22.2	12.3	90.4	76.1	1.9	29.6	0
13	25.3	14.1	89.8	75.7	2.3	27.8	0
14	30.5	18.3	80.4	56.1	0	30.1	0
15	29.7	16.2	82.3	59.9	0	33.6	0
16	30.3	19.3	82.3	67.9	0.36	38.4	1.7
17	32.2	21.7	72.1	47.3	0.49	29.2	3
18	31.2	20	73.4	61.1	6.46	26.7	3.5
19	24.2	16.5	91.3	92.9	6.71	24.9	4.1
20	29.2	19.1	90.9	74.6	6.29	17.7	4.5
21	31.4	19.9	86.1	79.9	2.87	16	5.1
22	27.1	18.9	92.6	85	49.2	15.32	5.8
23	27.8	20.3	92.3	80.7	4.81	12.61	7.1
24	26.6	20.4	96.7	89.3	21.93	8.8	5.5
25	25.5	20.3	92.7	89.7	21.91	7.3	6.4

Table 5: Total no. of major insect pests recorded in different locations viz., Umsning, Nongpoh and Bhoirymbong

	March-June 2024									
		Umsning			Nongpoh			Bhoirymbong		
		Villages			Villages			Villages		
		Umtrew	Umbang		Umta	Kharpati		Kyrdem	Mawkyrdep	
Sl. No.	Major insect pests	No. of individuals		Total	No. of individuals		Total	No. of individuals		Total
1.	<i>Aphis gossypi</i>	475	320	795	225	308	533	300	297	597
2.	<i>Myzus persicae</i>	280	320	600	295	265	560	340	265	605
3.	<i>Scirtothrips dorsalis</i>	120	128	248	90	81	171	81	70	151
4.	<i>Bemisia tabaci</i>	35	21	56	42	28	70	55	56	111
5.	<i>Helicoverna armigera</i>	35	25	60	50	40	90	40	35	75

Table 6: Per cent (%) fruit infestation of *Helicoverpa armigera* recorded in locations viz., Umsning, Nongpoh and Bhoirymbong

March-June 2024									
Umsning			Nongpoh			Bhoirymbong			
Umtrew	Umbang		Umta	Kharpati		Kyrdem	Mawkyrdep		
Mean per cent (%) fruit infestation		Total	Mean per cent (%) fruit infestation		Total	Mean per cent (%) fruit infestation		Total	Total
10.43	8.67	19.1	11.34	8.74	20.08	9.32	7.98	17.3	

Table 7: Relative abundance of natural enemies, pollinators, visitors recorded in Chilli ecosystem.

	Natural enemies					
Sl. No.	Common name	Scientific name	Family	Order	No. of individuals	Average relative abundance (%)
1.	Ladybird beetle	<i>Coccinella septumpunctata</i>	Coccinellidae	Coleoptera	27	16.66
2.		<i>Coccinella transversalis</i>	Coccinellidae	Coleoptera	25	15.43
3.		<i>Henosepilachna vigintioctopunctata</i>	Coccinellidae	Coleoptera	21	12.96
4.		<i>Oenopia sexareata</i>	Coccinellidae	Coleoptera	18	11.11
5.		<i>Micraspis discolour</i>	Coccinellidae	Coleoptera	16	10.09
6.		<i>Coelophora inaequalis</i>	Coccinellidae	Coleoptera	14	8.64
7.		<i>Brumoides saturalis</i>	Coccinellidae	Coleoptera	10	6.17
8.	Dragonfly	<i>Diplacodes trivialis</i>	Libellulidae	Odonata	10	6.17
9.	Preying mantids	<i>Mantis religiosa</i>	Mantidae	Mantodea	8	4.93
10.	Spider	<i>Oxyopes</i> spp.	Oxyopidae	Araneae	7	4.32
11.		<i>Araneus marmoroides</i>	Araneidae	Araneae	6	3.70
	Pollinators					
Sl. No.	Common name	Scientific name	Family	Order	No. of individuals	Average relative abundance (%)
1.	Honeybee	<i>Apis</i> spp.	Apidae	Hymenoptera	21	21
2.	Paper wasp	<i>Polistes</i> spp.	Vespidae	Hymenoptera	18	18
3.	Scolid wasp	<i>Scolia dubia</i>	Scoliidae	Hymenoptera	11	11
4.	Blue flower wasp	<i>Austroscolia soror</i>	Scoliidae	Hymenoptera	9	9
5.	Hoverfly	<i>Episyrphus viridaureus</i>	Syrphidae	Diptera	15	15
6.		<i>Episyrphus balteatus</i>	Syrphidae	Diptera	11	11
7.	Handmaiden moth	<i>Syntomoides imaon</i>	Erebidae	Lepidoptera	8	8
8.	Pansy butterfly	<i>Junonia lemonias</i>	Nymphalidae	Lepidoptera	7	7
	Visitors					
Sl. No.	Common name	Scientific name	Family	Order	No. of individuals	Average relative abundance (%)
1.	Ground bug	<i>Lygaeus equestris</i>	Lygaeidae	Coleoptera	8	17.77
2.	Bush cricket	<i>Elimaea fallax</i>	Tettigoniidae	Orthoptera	5	11.11
3.		<i>Homoeoxipha lycoides</i>	Gryllidae		4	8.88
4.		<i>Neoconocephalus palustris</i>	Tettigoniidae		3	6.66
5.	Jewel beetle	<i>Chrysochroa buqueti</i>	Buprestidae	Coleoptera	4	8.88
6.	Blister beetle	<i>Mylabris phalerata</i>	Meloidae		3	6.66
7.	Cinium borer	<i>Brithys crini</i>	Noctuidae	Lepidoptera	3	
8.	Click beetle	<i>Hemiops flava</i>	Elateridae	Coleoptera	3	
9.	Soldier fly	<i>Ptecticus trivittatus</i>	Stratiomyidae	Diptera	3	
10.	Blow fly	<i>Lucilia</i> spp.	Calliphoridae	Diptera	3	
11.	Tortoise beetle	<i>Dorynota</i> spp.	Chrysomelidae	Coleoptera	2	4.44
12.	Longhorned beetle	<i>Nupserha fricator</i>	Cerambycidae	Coleoptera	2	
13.	Crane fly	<i>Nephrotoma virgata</i>	Tipulidae	Diptera	2	