



Insect pests and natural enemy complex of brinjal, *Solanum melongena* L. in Meghalaya

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ABSTRACT

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A study on "Insect pests and natural enemy complex of brinjal *Solanum melongena* L. in Meghalaya" was conducted in experimental farm of College of Post Graduate Studies in Agricultural Sciences (CPGS-AS), Umiam, Meghalaya from April to July, 2021. A total of twenty-two insect species and three non-insects were recorded from the brinjal ecosystem, out of which fifteen species were observed as insect pests, six species as predators, one species as pollinator and three species of predatory spiders from the brinjal ecosystem. The correlation studies of the pests (aphids, jassids, hadda beetle and BSFB) with weather parameters (maximum and minimum temperature, maximum and minimum relative humidity and rainfall) revealed that temperature and R.H. had significantly positive relationship with population fluctuation of the pests.

1. Introduction

Brinjal is a prominent solanaceous vegetable crop which is grown over an area of 1.8 million hectares and produced 55.19 million tonnes globally (Anonymous, 2019). Due to its high productivity and nutritional value, brinjal is rightfully referred to as the "King of Vegetables". It is primarily water, with some protein, fibre, and carbohydrates, and is low in calories and fats (Gopalan *et al.*, 2007). It is cultivated on 7.3 lakh ha of land in India, with yearly production and productivity of 128.01 lakh M T and 19.1 M T ha⁻¹, respectively, in 2017–18. (Anonymous, 2018). It is grown in Meghalaya on an area of 1.08 thousand ha, with a production of 15.21 thousand MT and productivity of 14.10 M T ha⁻¹ (Anonymous, 2018) which is much lower than the national average. Damage caused by pests and diseases are the major factors responsible for the low production of the crop. A total of 27 insect pest species were associated with brinjal crop during different stages of crop growth in an overlapping manner (Anjana and Mehta, 2008). Among them, the major insect pests include- Brinjal fruit and shoot borer (*Leucinodes orbonalis* Guen), aphids (*Aphis gossypii* Glover), jassids (*Amrasca bigutulla bigutulla* Ishida), stem borer (*Euzophera perticella* Ragonot), epilachna beetle (*Henosepilachna vigintioctopunctata* Fabaceous), white fly (*Bemisia tabaci* Gennadius), lacewing bug (*Urantius hystricellus* Distant) and non-insect pest- red spider mite

(*Tetranychus macfurlanei*). Among these insect pests, the most damaging one in South and South-East Asia is the brinjal fruit and shoot borer (BFSB). The extent of damage of the pest may range from 70-92% (Dhandapani *et al.*, 2003). The same habitat is home to a variety of arthropod pests that are their natural enemies. According to Latif *et al.* (2009), the ecology surrounding brinjal is home to 10 predatory arthropod species and 20 hazardous species of arthropods.

2. Materials & Methods

Field study was conducted in experimental farm of College of Post Graduate Studies in Agricultural Sciences (CPGS-AS), Umiam, Meghalaya from April to July, 2021. Regular surveys were carried out at weekly intervals to record and collect the insect fauna starting from vegetative to harvesting stages of brinjal crop (variety Pusa Purple Long). Insect pests were recorded based on their damage and infestation, natural enemies on the basis of parasitism and predation and pollinators were simultaneously observed and collected. Insects were collected by hand picking, insect sweep net and aspirators. The identification of the collected insects was done based on the established taxonomic keys and on available literature of pests' complex on brinjal crop. The weekly incidence of major insect pests associated with brinjal crop during the entire cropping season, was correlated along with the weekly meteorological data *viz.*, temperature

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(Maximum and minimum), per cent relative humidity (morning and evening) and rainfall. To study the influence of weather parameters on the incidence and population of major insect pests of brinjal, correlation co-efficient was calculated by using the formula given by Pearson (1973).

$$\text{Correlation co-efficient } (r) = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}}$$

3. Results

A total of 22 insect species and 3 non-insects were collected from brinjal crop and were identified, of which 15 species were recorded as insect pests, 6 species as predators and 1 species of pollinator. Among non-insect pests, 3 species of spiders were identified. 15 species of insect pests viz., aphids (*Aphis gossypii* Glover), jassids (*Amrasca biguttula biguttula* Ishida), hadda beetle (*Epilachna vigintioctopunctata* Fab.), shoot and fruit borer (*Leucinodes orbonalis* Guen.), brinjal leaf beetle (*Psylliodes balyi* Jacoby), white spotted flea beetle (*Monolepta signata* Oliv), blister beetle (*Mylabris phalerata*), red pumpkin beetle (*Aulacophora foveicollis*), seed bug (*Lygaeus hospes*), fruit fly (*Bactrocera dorsalis*, *B. zonata*, *B. tuberculata*), eggplant horned planthopper (*Leptocentrus taurus*), cabbage looper (*Trichoplusia ni*), death's-head hawkmoth (*Acherentia styx*), green sting bug (*Nezara viridula*) and tussock moth (*Orgyia* spp.) were recorded on brinjal crop (Table 1). The natural enemies recorded from brinjal ecosystem were 6 species of lady bird beetles (*Coccinella septempunctata*, *Cheilomenes sexmaculata*, *Cheilomenes propinqua* (Muls.), *Micraspis discolor*, *Oenopia sexareata* and *Coelophora bissellata*) and 3 species of spiders Burmese lynx spider (*Oxyopes birmanicus*), Striped lynx spider (*Oxyopes salticus*) and Wolf Spider (*Pardosa* spp.) (Table 2 and 3). Among all the pests, the shoot and fruit borer (*Leucinodes orbonalis* Guen.) was identified as the most serious brinjal pest.

3.1 Population build up of major insect pests in relation to weather parameters

Aphids (*Aphis gossypii* Glover) At the vegetative stage of the crop, the first invasion of aphid was seen which continued throughout the cropping season. The maximum population (12.30 aphids/plant) was recorded in the last week of June i.e. 26th SMW where the average maximum and minimum temperature, average maximum and minimum R.H and rainfall was 26.99°C, 20.66°C, 90.14%, 86.14%, 63.60 mm, respectively (Table 5).

Jassids (*Amrasca biguttula biguttula* Ishida) It was witnessed that *A. biguttula biguttula* infestation was seen during the entire growing stage of the crop. The incidence of jassids was noticed from the last week of April and remained till the picking stage of the crop. The maximum population (6.25 jassids/plant) was observed in the first week of June i.e. on

24th SMW when the average maximum and minimum temperature, average maximum and minimum R.H and rainfall was 29.04°C, 20.97°C, 89.28%, 74.28%, 6.11 mm, respectively (Table 5).

Hadda beetle (*Henosepilachna vigintioctopunctata* Fab.)

From the first week of May to the last week of July, the Hadda beetle was found active on the crop. There was a less population in the beginning. The population gradually increased and reached maximum intensity (2.55 beetle/plant) on 27th SMW when the average maximum and minimum temperature, average maximum and minimum R.H and rainfall was 26.83°C, 20.27°C, 88.71%, 85.57%, 96.20 mm, respectively (Table 5).

Shoot and Fruit Borer (*Leucinodes orbonalis* Guen.)

The shoot and fruit borer of brinjal is the most important pest of the region. The infestation was first observed on shoots from May and prevailed in the field till the maturity stage of the crop. The shoot infestation was highest (22.40%) during 23rd SMW when the average maximum and minimum temperature, average maximum and minimum R.H and rainfall was 28.78°C, 20.24°C, 88.28%, 74.00% and 4.90 mm, respectively (Table 5). The highest fruit infestation (38.84%) was found on 28th SMW when the average maximum and minimum temperature, average maximum and minimum R.H and rainfall was 28.16°C, 20.84°C, 88.57%, 79.71% and 79.40 mm, respectively (Table 5).

3.2 Correlation with weather parameters The correlation of aphid population was found significantly positive ($r=0.55^*$, $r=0.65^*$ and $r=0.51^*$) with minimum temperature, maximum and minimum relative humidity and non-significantly positive ($r=0.42$ and $r=0.39$) with maximum temperature and rainfall. The jassid population was found significantly positively correlated with minimum temperature, maximum and minimum relative humidity with r values of 0.69*, 0.86* and 0.64*, respectively and non-significantly positive with rainfall ($r=0.10$) and negatively correlated ($r=-0.07$) with maximum temperature. The population of hadda beetle was recorded significantly positive ($r=0.18^*$ and $r=0.67^*$) with maximum and minimum temperature, non-significantly positive with maximum and minimum relative humidity and rainfall with $r=0.33$, $r=0.35$ and $r=0.65$, respectively. The correlation of shoot infestation of BSFB was found non-significantly positive $r=0.46$, $r=0.44$, $r=0.53$ and $r=0.25$ with maximum and minimum temperature, maximum and minimum relative humidity and negative correlation ($r=-0.19$) with rainfall. The correlation of fruit infestation of BSFB was significantly positive ($r=0.69^*$) with minimum temperature and non-significant with maximum temperature, maximum and minimum relative humidity and rainfall ($r=0.63$, $r=0.44$, $r=0.45$ and $r=0.40$, respectively).

4. Discussion

The current study indicated that the brinjal ecosystem had a diverse mix of insect pest species, natural enemies, and pollinators. These findings are supported by Singh and Singh (2002) who reported 27 insect and non-insect pests infesting the brinjal crop in Meghalaya. Borkakati *et al.* (2019) recorded 5 species of coccinellid predators as

major predators of aphids and leafhoppers in brinjal ecosystem similar to the present studies. Among the various pests species reported from the brinjal crop, brinjal shoot and fruit borer was found to be the major pest. These results are similar to the findings of Gangwar and Singh (2014) who also found brinjal shoot and fruit borer as the major pest of brinjal.

Table 1. Insect pests complex associated with brinjal (Var. Pusa Purple Long)

Sl. No.	Common name	Scientific name	Order: Family	Feeding site	Insect pest status	Images of adult insects
1.	Shoot and fruit borer	<i>Leucinodes orbonalis</i>	Lepidoptera: Pyralidae	Shoot and fruit	Major	
2.	Hadda beetle	<i>Henosepilachna vigintioctopunctata</i>	Coleoptera: Coccinellidae	Leaf	Minor	
3.	Aphid	<i>Aphis gossypii</i>	Homoptera: Aphididae	Leaf	Minor	
4.	Jassid	<i>Amrasca bigutulla bigutulla</i>	Homoptera: Cicadellidae	Leaf	Minor	
5.	Flea beetle	<i>Monolepta signata</i>	Coleoptera: Chrysomelidae	Leaf	Minor	
6.	Brinjal leaf beetle	<i>Psylloides balyi</i>	Coleoptera: Chrysomelidae	Leaf	Minor	
7.	Seed bug	<i>Lygaeus hospes</i>	Hemiptera: Lygaeidae	Plant sap	Minor	
8.	Blister beetle	<i>Mylabris phalerata</i>	Coleoptera: Meloidae	Flowers	Moderate	
9.	Red pumpkin beetle	<i>Aulacophora foveicollis</i>	Coleoptera: Chrysomelidae	Foliage and flowers	Minor	

10.	Fruit fly	<i>Bactrocera dorsalis</i> <i>B. zonata</i> <i>B. tuberculata</i>	Diptera: Tephritidae	Fruits	Minor	
11.	Eggplant Horned Planthopper	<i>Leptotocentrus Taurus</i>	Homoptera: Membracidae	Plant sap	Minor	
12.	Cabbage looper	<i>Trichoplusia ni</i>	Lepidoptera: Noctuidae	Leaves	Minor	
13.	Death's- head hawkmoth	<i>Acherentia styx</i>	Lepidoptera: Sphingidae	Leaves	Minor	
14.	Green Sting Bug	<i>Nezara viridula</i>	Hemiptera: Pentatomidae	Leaves	Minor	
15.	Tussock Moth	<i>Orgyia</i> spp	Lepidoptera: Erebidae	Leaves	Minor	

Table 2. Natural enemies (predators) of insect pests recorded in brinjal ecosystem




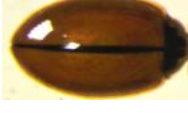


Sl. No.	Common name	Scientific Name	Order: Family	Prey	Prey Stage	Images of adult predator
1.	Lady bird beetle	<i>Coccinella septumpunctata</i>	Coleoptera: Coccinellidae	<i>A. gossypii</i>	Nymph and adult	
2.	Lady bird beetle	<i>Cheilomenes sexmaculata</i>	Coleoptera: Coccinellidae	<i>A. gossypii</i>	Nymph and adult	
3.	Lady bird beetle	<i>Cheilomenes propinqua</i> (Muls.)	Coleoptera: Coccinellidae	<i>A. gossypii</i>	Nymph and adult	
4.	Lady bird beetle	<i>Micraspis discolor</i>	Coleoptera: Coccinellidae	<i>A. gossypii</i>	Nymph and adult	
5.	Lady bird beetle	<i>Oenopia sexareata</i>	Coleoptera: Coccinellidae	<i>A. gossypii</i>	Nymph and adult	
6.	Lady bird beetle	<i>Coelophora bissellata</i>	Coleoptera: Coccinellidae	<i>A. gossypii</i>	Nymph and adult	

Table 3. Natural enemies (spiders) of insect pests recorded in brinjal ecosystem



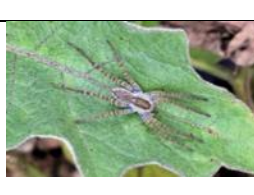

Sl. No.	Common name	Scientific Name	Order: Family	Status of spiders	Images of Spiders
1.	Burmese lynx spider	<i>Oxyopes birmanicus</i>	Araneae: Oxyopidae	Major	
2.	Striped lynx spider	<i>Oxyopes salticus</i>	Araneae: Oxyopidae	Major	
3.	Wolf Spider	<i>Pardosa</i> spp	Araneae: Lycosidae	Minor	

Table 4. Major pollinators recorded in brinjal ecosystem

Sl. No.	Common name	Scientific Name	Order: Family	Status	Adult bumble bee image
1.	Bumble Bee	<i>Bombus</i> spp	Hymenoptera: Apidae	Major	

4.1 Population build up in relation to weather parameters

Aphids (*Aphis gossypii*) From the fourth week of April till the maturity stage, the crop was infested by aphids. In the last week of June, the aphid population peaked when the maximum and minimum temperature, maximum and minimum relative humidity and rainfall were favourable for aphids reproduction. These findings are in conformity with earlier work of Dhamdhree *et al.* (1995) and Borah (1995) also reported that *Aphis gossypii* was prevalent from the first week after transplanting to the maturity of the brinjal crop.

Jassids (*Amrasca bigutulla bigutulla*) The incidence of jassids was reported after a week of transplanting and continued till the picking stage of the crop. The population was found maximum in the first week of June when the maximum and minimum temperature, maximum and minimum relative humidity and rainfall were favourable for jassid reproduction. Similar results were presented by Mohammad *et al.* (2019) who found the abundance of the pest throughout the cropping season and also reported the peak of the pest during the first week of June.

Hadda Beetle (*Henosepilachna vigintipunctata*) Hadda beetle population was seen in the brinjal crop from the first week of June to the last week of July with a peak abundance in the first week of July month when the maximum and minimum temperature, maximum and minimum relative humidity and rainfall were favourable for beetles reproduction. According to Ghosh and Senapathi (2002), the hadda beetle was active on brinjal from April to mid-October, with the greatest numbers was recorded in mid-September, which is not in conformity with the present work which might be due to different geographical location and climate.

Shoot and fruit borer (*Leucinodes orbonalis*) Although shoot and fruit borer is a significant pest in this area, its population was non-existent throughout the early stages of crop growth during the experiment. From the first week of May until the crop is harvested, the population began to rise and peaked on 23rd SMW. The highest fruit infestation was recorded on 28th SMW, in the second week of July. The current findings correspond in part with the findings of Rashid *et al.* (2003) who reported that the maximum degree of shoot and fruit borer infection occurred from June to September. The current study is also supported by the works of Kumar *et al.* (2017) who stated that the infestation in shoots by the pest started in

initial growing stage whereas fruit infestation progressed in advanced stage and further increased with time.

4.2 Correlation with weather parameters

Aphid population was positively correlated with minimum temperature maximum and minimum relative humidity and non-significantly correlated with maximum temperature and rainfall. The results showed that RH and minimum temperature were the most important factors in aphid population build-up on plants. The current findings are in conformity with the studies conducted by Pathipati *et al.* (2014) who also reported significant positive correlation of aphid with minimum temperature and maximum and minimum relative humidity. This may be because the aphids which are present in lower surface of leaves are not likely to cause any significant correlation with weather parameters. The jassid population had a significant positive correlation with minimum temperature, maximum and minimum relative humidity, respectively and non-significant positive correlation with rainfall. The jassid population was negatively

correlated with maximum temperature. Ghosh and Bhattacharyya (2018) also reported that jassid population showed negative correlation with maximum temperature and significant positive correlation with minimum temperature and relative humidity. Chandrakumar *et al.* (2008) also found significant positive relationship of hadda beetle population with maximum and minimum temperatures and non-significant positive correlation with the incidence of hadda beetle other weather parameters.

The relationship between BSFB shoot infestation and maximum and minimum temperature, maximum and minimum relative humidity was non-significantly positive. Shyamprasad and Logiswaran (1998) supported the present results who also reported non-significantly positive correlation between BSFB shoot infestation and maximum and minimum temperature, maximum and minimum relative humidity. Kumar and Singh (2013) also reported significant relationship of fruit infestation of BSFB with minimum temperature.

Table 5. Seasonal incidence of major insect-pests of brinjal

Date	SMW*	No. of Aphids/plant	No. of Jassids/plant	No. of Hadda beetles/plant	BSFB**	
					Shoot infestation (%)	Fruit infestation (%)
16-04-2021	16	0.0	0.0	0.0	0.0	0.0
23-04-2021	17	0.0	0.0	0.0	0.0	0.0
30-04-2021	18	0.65	0.48	0.0	0.0	0.0
07-05-2021	19	1.20	3.10	0.15	4.30	0.0
14-05-2021	20	2.78	3.35	0.45	6.40	0.0
21-05-2021	21	2.88	4.35	0.80	10.63	0.0
28-05-2021	22	5.20	5.15	1.05	16.43	0.0
04-06-2021	23	7.80	6.15	0.82	22.40	10.57
11-06-2021	24	8.65	6.25	1.55	15.50	15.34
18-06-2021	25	10.80	5.70	2.07	8.10	20.35
25-06-2021	26	12.30	5.00	1.86	6.66	28.57
02-07-2021	27	10.20	4.30	2.55	4.80	33.88
09-07-2021	28	11.15	4.00	2.07	4.10	38.84
16-07-2021	29	8.85	3.55	1.53	5.00	25.85
23-07-2021	30	9.30	3.85	1.22	3.90	20.34
30-07-2021	31	7.30	3.00	0.9	3.66	18.21

*SMW- Standard meteorological week; ** BSFB- Brinjal shoot and fruit borer

Insects	Temperature (°C)		R.H (%)		Rainfall (mm)
	Max.	Min	Max.	Min	
	r* values				
Aphid	0.42	0.55*	0.65*	0.51*	0.39
Jassid	-0.07	0.69*	0.86*	0.64*	0.10
Hadda Beetle	0.18*	0.67*	0.33	0.35	0.65
BSFB (Shoot damage)	0.46	0.44	0.53	0.25	-0.19
BSFB (Fruit damage)	0.63	0.69*	0.44	0.45	0.40

*Correlation is significant at 5% level; Non-significant (without asteric)

r* Correlation values

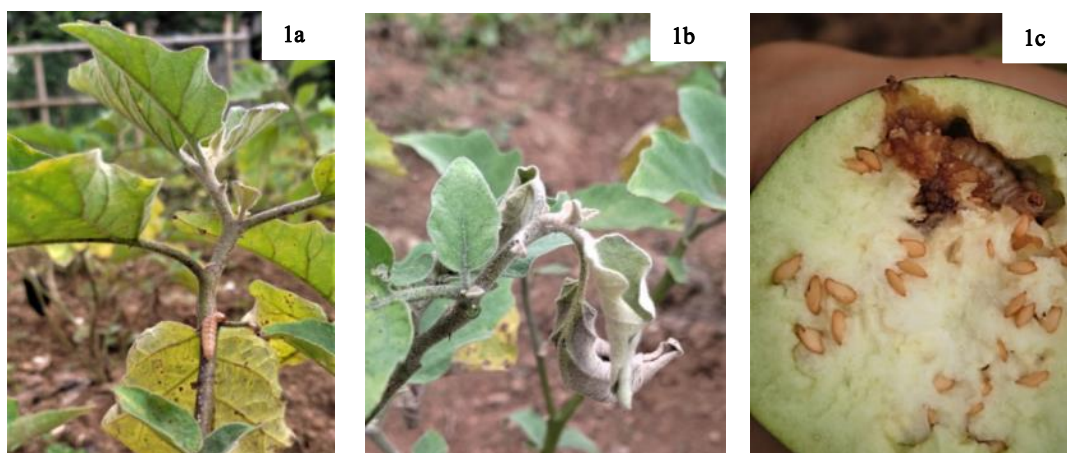


Plate 1 (a-c) Infestation of brinjal shoot and fruit borer (*Leucinodes orbonalis*) in different stages of brinjal crop recorded during experimentation [a and b -Shoot infestation, c- Fruit infestation]

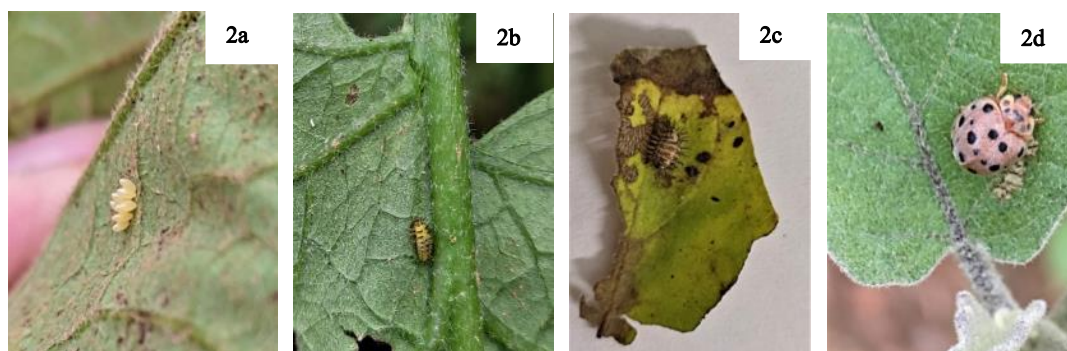
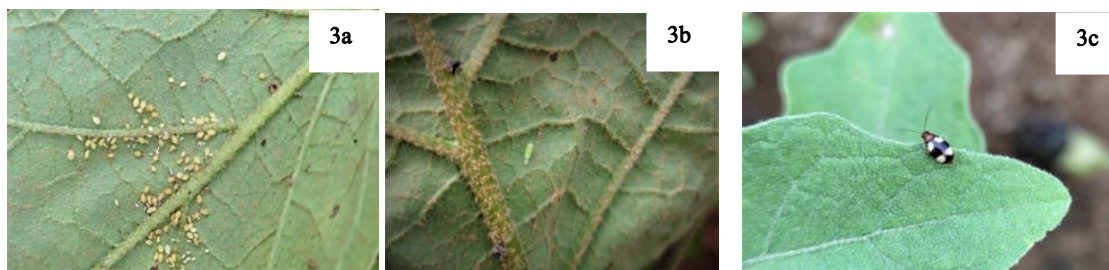


Plate 2 (a-d) Infestation by different stages of hadda beetle (*Henosepilachna vigintipunctata*) recorded in brinjal ecosystem during experimentation [a- Eggs, b and c- Grub, d- Adult]



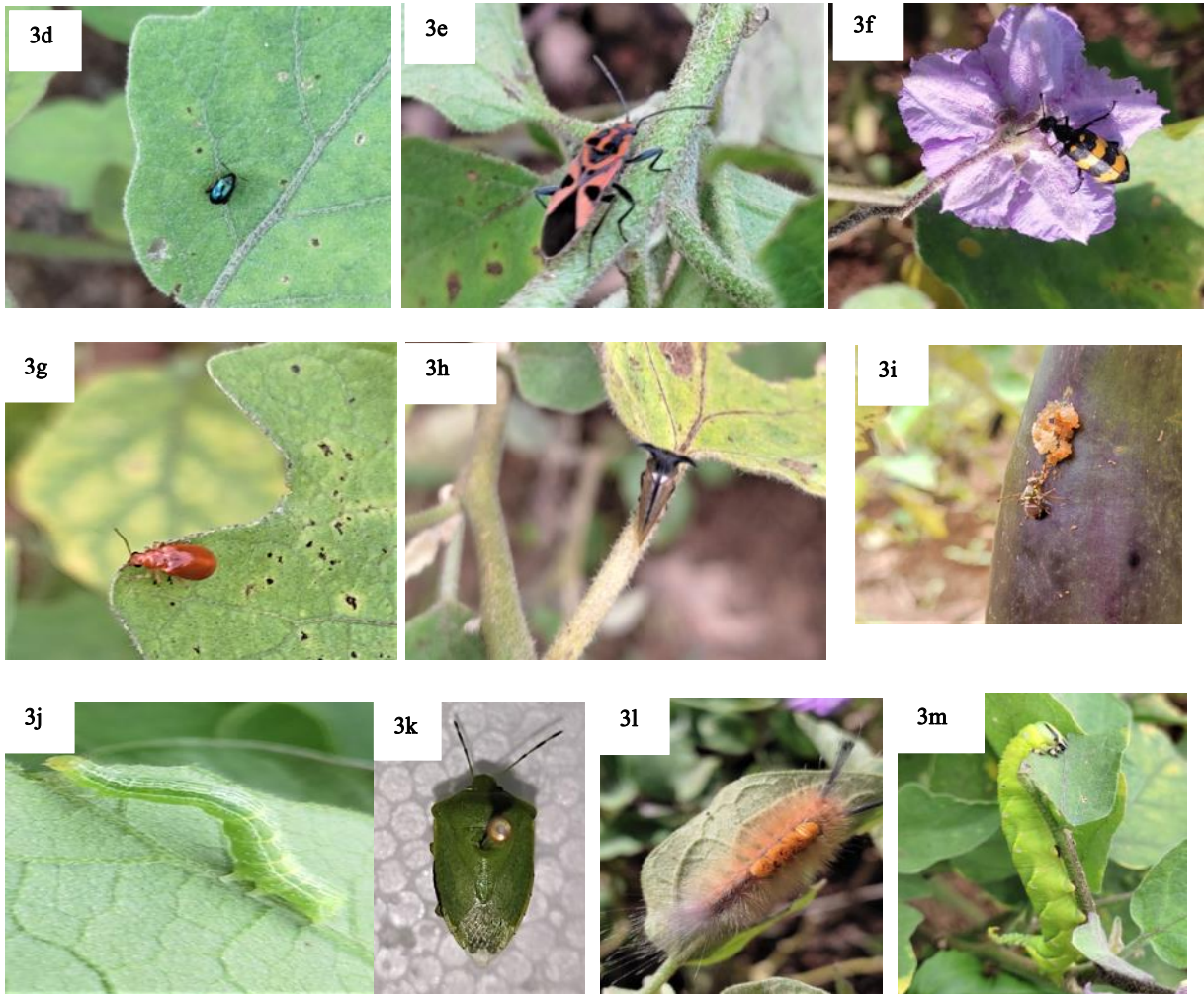


Plate 3 (a-m) Infestation of various insect pests recorded in brinjal ecosystem during experimentation

[a- Aphid (*Aphis gossypii*) b- Jassid (*Amrasca bigutulla bigutulla* c- Flea beetle (*Monolepta signata*) d- Brinjal leaf beetle (*Psylloides balyi*) e- Seed bug (*Lygaeus hospes*) f- Blister beetle (*Mylabris phalerata*) g- Red pumpkin beetle (*Aulacophora foveicollis*) h- Eggplant horned plant hopper (*Leptotocentrus taurus*) i- Fruit fly (*Bactrocera dorsalis*) j- Cabbage looper (*Trichoplusia ni*) k- Green sting bug (*Nezara viridula*) l- Tussock moth (*Orgyia* spp) m- Death's hawk moth (*Acherentia styx*)]

Natural Enemies

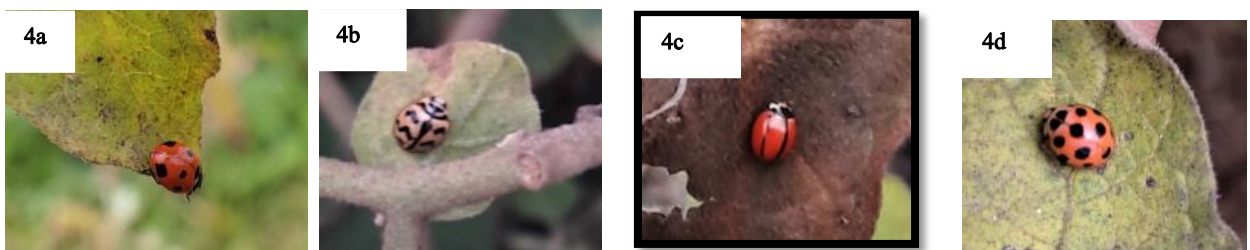




Plate 4(a-h) Different species of lady bird beetles recorded in brinjal ecosystem during experimentation

[a- *Coccinella septempunctata* b- *Cheilomenes sexmaculata* c- *Cheilomenes propinqua* d- *Coelophora bissellata* e- *Micraspis discolor* f- *Oenopia sexareata* g- *Coccinella septempunctata* h-*Coelophora bissellata*]

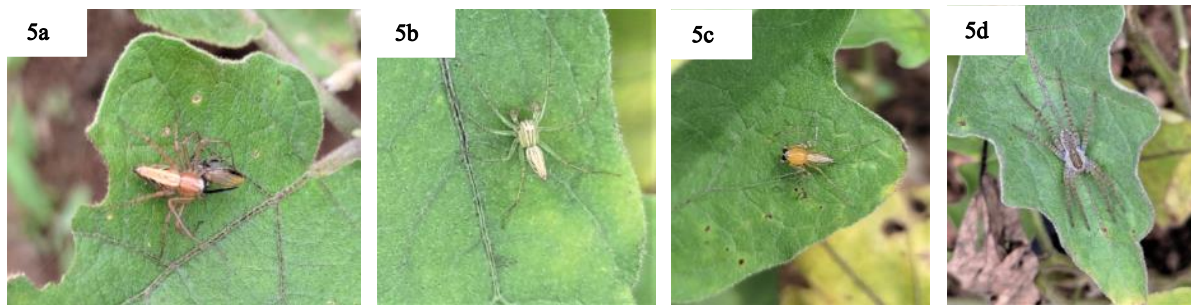


Plate 5 (a-d) Different species of spiders recorded in brinjal ecosystem during experimentation

[a and b- *Oxyopes birmanicus*, c- *Oxyopes salticus*, d- *Pardosa* spp.]



Plate 6 Pollinator (*Bombus* spp.) recorded in brinjal ecosystem during experimentation

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