International Journal of Entomology Research
www.entomologyjournals.com
ISSN: 2455-4758
Received: 03-09-2025, Accepted: 03-10-2025, Published: 18-10-2025
Volume 10, Issue 10, 2025, Page No. 42-45

Assessment of insect pests complex and their natural enemies in local Chilli (*Capsicum annuum* L.)

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Abstract
A field experiment was conducted in the experimental farm at New Colony, Ward-7, Chumukedima, Nagaland from February to May 2021 in order to study the "Assessment of Insect Pests Complex and their Natural Enemies in Local Chilli (*Capsicum annuum* L.)". The study was conducted in Randomized Block Design with five treatments including one control having four replications. Chilli was transplanted on Date 23. 02. 2021 and the treatments used were *Beauveria bassiania* (0.5 ml/L of water), Tobacco leaf extract (5ml/L of water), Neem oil (5 ml/L of water) and Ginger Garlic paste (50 g/L of water). Nine insect pests under seven orders and ten families were observed infesting chilli. Among them, the incidence of aphids, whitefly, thrips and fruit borer were observed to be the important pests while others were negligible. The incidence of aphids, whitefly and thrips was observed initially in the field at 6th SMW. The incidence of fruit borer was observed initially in the field at 14th SMW. Also, several natural enemies were observed during the experiment. Maximum temperature and relative humidity exhibited positive and non-significant correlation on the incidence of aphids, thrips and fruit borer while for whitefly maximum and minimum temperature showed negatively non-significant correlation. However, all the other weather parameters showed positive non-significant effect on the incidence of all the major pests.

Keywords: Pest complex, natural enemies, Chilli, Nagaland

Introduction
Chilli, *Capsicum annum* L. is an important spice crop grown in India and it was originated in Mexico. It belongs to Solanaceae family and are rich source of Vitamin C. Pungency in chilli is due to the presence of alkaloid called capsaicin and red color of chilli is due to the presence of capsanthin. Chilli is grown for the purposes of its spiciness and pungency and they are consumed both in green, ripe and latter dried form. Two species of chilli *viz*., *Capsicum annum* L. and *Capsicum frutescence* L. are well known in India. Karnataka has the highest chilli production i.e. 673.81 Metric Tonnes while in Nagaland, the production of chilli is 44.50 Metric Tonnes (Horticulture Statistics 2017-18). Regrettably, chilli is attacked by several insect pests right from sowing till harvesting which is one of the major limiting factors causing significant yield loss (Roopa and Kumar 2014) [5]. Gupta *et al*. (2016) [3] reported infestation of whitefly (*Bemisia tabaci*), aphids (*Aphis gossypii*), on chilli *Capsicum annum* L. Similarly, Mousumi *et al*. (2018) [4] observed chilli thrips (*Scirthothrips dorsalis*) and fruit borer (*Helicoverpa armigera*) infesting chilli plants. Chilli, being one of the important spice crops grown in India plays an important role in boosting the country's economy. However, because of the infestation caused by insect pests, it reduces the quality as well as quantity of chilli fruits and adversely affects its production. The infected fruits become unfit for human consumption and hence unmarketable. Therefore, proper insect pest's management should be adopted in order to prevent the crop from economic loss. Over the years, farmers had been over dependent on chemical pesticides for controlling insect pests, which in return not only caused harm to environment and humans but also leads to various problems like soil depletion, soil erosion, pest's resistance. Thus, keeping in view the severity to the insect pests attack and importance of the crop, the present study "Assessment of Insect Pests Complex and their Natural Enemies in Local Chilli (*Capsicum annuum* L.)" was carried out.

Materials and Methods
Field experiment was carried out during February 2021 to May 2021, in the Experimental Farm, New Colony, Ward 7, Chumukedima, Nagaland. The population count for the insect pests was carried out throughout the cropping period i.e. appearance of pest till harvesting of crop. For sap sucking pests such as aphids, whitefly, pest population was counted from 3 shoots i.e. top, middle and bottom from 5 randomly selected plants in each plot. For fruit borer, pest count was made from fruits of 5 randomly selected plants in each plot at weekly interval. Leaf eating pests such as caterpillars, beetles, grasshoppers were collected in glass jars or entomological glass tubes with the help of forceps. Flower feeding pests such as thrips was counted from 5 infested flowers of 5 randomly selected plants per plot. The insect pests were counted and collected in weekly interval by shaking or opening the flower petal on a white blank paper. The experiment was laid out in Randomized Block Design (RBD) with three replications. There were five treatments *viz*., *Beauveria bassiania* (0.5 ml L^{-1} of water), tobacco leaf extract (5 ml L^{-1} of water), neem oil (5ml L^{-1} of water), ginger garlic paste (50g L^{-1} of water) and one untreated plot. The treatments were given after the appearance of the pest population and the second application was carried out after 15 days from first spray readings. The observation on the efficacy of different treatments was recorded as pre and post treatment at 3, 5, 7

and 9 days after spray. The pest population was recorded one day before application of treatments of each pest population as per the above described sampling methods. To assess the efficacy of each treatment, the mean percentage of reduction of the infestation was calculated from the following formula given by

$$\text{Percent Reduction} = \frac{\text{Pre treatment count} - \text{Post treatment count}}{\text{Pre treatment count}} \times 100$$

The data noted throughout the period of study were tabulated and tested adopting the procedure of two-way analysis of variance method as outlined by Gomez and Gomez (1984) and the treatment variance was tested against error mean square by applying Fisher Snedecor 'F' probability at 0.05 level of significance.

Results and Discussion

The data related to the Insect pest complex of chilli and their incidence are given in Table 1 and 2.

Insect pest complex of chilli and their incidence

The data on the pest complex and their incidence were recorded at one-week interval from a separate ecological plot to maintain their incidence at natural condition. Several insect pests were observed feeding at different stages of the crop. Those pests recorded were identified at the laboratory in Department of Entomology, NU, SAS, Medziphema, Nagaland. The result thus obtained is described in the following sub-headings mentioned below.

Pest complex and natural enemies of chilli at different growth stages of the crop during the period of investigation (February to May 2021)

In the present study, eight insect pests under five orders and eight families were observed associating with chilli crop (Table 1) during the rabi season of 2021. Among these, there were sap sucking pests like aphids, *Aphis gossypii* Glover (*Hemiptera: Aleyrodidae*), whitefly, *Bemisia tabaci* Gennadius (*Hemiptera: Aleyrodidae*), Mites, *Polyphagotarsonemus latus* Banks (*Araci: Tarsonemidae*), mealy bugs, *Pheanacoccus solenopsis* Tinsley (*Hemiptera*: *Pseudococcidae*), leaf feeders pests like thrips, *Scirthothrips dorsalis* Hood (*Thysanoptera: Thripidae*), jassids, *Amrasca biguttula* Ishida (*Hemiptera*: *Cicadellidae*), grasshopper, *Omocestus viridulus* Linnaeus (*Orthoptera: Acrididae*), fruit feeders like fruit borer, *Helicoverpa armigera* Hubner (*Lepidoptera*: *Noctuidae*). Two natural enemies Coccinellids, *Coccinella transversalis* Fabricius (*Coleoptera: Coccinellidae*) and Preying mandits, *Mantis religiosa* Linnaeus (*Mantodea: Mandidae*) were also observed.

Table 1: Insect pest's complex recorded on chilli during February 2021 to May 2021

Sl. No.	Common Name	Scientific Name/Order/Family	Crop Phenology	Feeding Site
1.	Aphids	*Aphis gossypii* Glover (*Hemiptera: Aleyrodidae*)	Vegetative stage till harvest	Leaves and tender parts of the plant
2.	Whitefly	*Bemisia tabaci* Gennadius (*Hemiptera: Aleyrodidae*)	Vegetative stage till harvest	Leaves and tender parts of the plant
3.	Thrips	*Scirthothrips dorsalis* Hood (*Thysanoptera: Thripidae*)	Vegetative stage till harvest	Leaves and tender parts of the plant
4.	Mealy bugs	*Phenacoccus solenopsis* Tinsley (*Hemiptera*: *Pseudococcidae*)	Vegetative stage till harvest	Leaves and tender parts of the plant
5.	Jassids	*Amrasca biguttula biguttula* Ishida (*Hemiptera*: *Cicadellidae*)	Vegetative stage till harvest	Leaves and tender parts of the plant
6.	Mites	*Polyphagotarsonemus latus* Banks (*Araci: Tarsonemidae*)	Vegetative stage till harvest	Leaves and tender parts of the plant
7.	Fruit borers	*Helicoverpa armigera* Hubner (*Lepidoptera*: *Noctuidae*)	Fruit formation stage	Fruit
8.	Grasshoppers	*Omocestus viridulus* Linnaeus (*Orthoptera: Acrididae*)	Vegetative stage till harvest	Leaves and tender parts of the plant

Among them, the incidence of aphids, whitefly, thrips and fruit borer were important while others were negligible. aphids, *Aphis gossypii* (*Hemiptera: Aleyrodidae*), whitefly, *Bemisia tabaci* (*Hemiptera: Aleyrodidae*), thrips, *Scirthothrips dorsalis* (*Thysanoptera: Thripidae*) and fruit borer, *Helicoverpa armigera* (*Lepidoptera*: *Noctuidae*) were recorded to be the most serious pests as they were active in the field for longer periods with abundant numbers. Other insects such as mites, *Polyphagotarsonemus latus* Banks (*Araci: Tarsonemidae*), mealy bugs, *Pheanacoccus solenopsis* (*Hemiptera*: *Pseudococcidae*), jassids, *Amrasca biguttula* (*Hemiptera*: *Cicadellidae*), grasshopper, *Omocestus viridulus* (*Orthoptera: Acrididae* were observed feeding on the plant parts, but their population was very scanty during the period of investigation. Two natural enemies coccinellids, *Coccinella transversalis* Fabricius (*Coleoptera: Coccinellidae*) and preying mandits, *Mantis religiosa* Linnaeus (*Mantodea: Mandidae*) were also observed feeding on general insects and aphids.

The observation of eight insect pests during the period of investigation is in conformity with the findings of several researchers, Gupta *et al*. (2016) [3] reported whitefly (*Bemisia tabaci*), aphids (*Aphis gossypii*), mites (*Polyphagotarsonemus latus*) infesting on chilli *Capsicum annum* L. Mousumi *et al*. (2018) [4] also reported several pests like chilli thrips (*Scirthothrips dorsalis*), fruit borer (*Helicoverpa armigera*) and mealybugs (*Pheanacoccus solenopsis*) infesting chilli. Serious among them were aphids, whitefly, thrips and fruit borer which cause a severe reduction in the yield (Mousumi *et al.* 2018) [4]. Saini *et al*. (2016) also observed sucking pests like thrips, whitefly and jassids and several other pests causing damage to chilli (*Capsicum annum* Linnaeus). Chintkuntlawar *et al*. (2015) [1] also observed and reported natural enemies like coccinellids and preying mandits.

Table 2: Incidence of pest complex and natural enemies in chilli during February 2021 to May 2021

Standard Mean week	Date of observation	Mean no. per leaf or plant									
		Aphis gossypii	*Bemisia tabaci*	*Scirthothrips dorsalis*	*Phenacoccus solenopsis*	*Amrasca biguttula*	*Polyphagotarsonemus latus*	*Helicoverpa armigera*	*Omocestus viridulus*	*Coccinella transversalis*	*Mantis religiosa*
6	08 Feb 21	0.60	1.35	0.35	0.00	0.20	0.00	0.00	0.00	0.15	0.00
7	15 Feb 21	0.75	1.35	0.65	0.00	0.15	0.05	0.00	0.00	0.25	0.00
8	22 Feb 21	0.70	1.80	1.10	0.00	0.50	0.00	0.00	0.00	0.55	0.05
9	01 March 21	1.40	2.45	1.80	0.10	0.15	0.00	0.00	0.00	0.45	0.00
10	08 March 21	1.25	1.65	1.60	0.75	0.15	0.25	0.00	0.00	0.35	0.00
11	15 March 21	1.60	2.45	1.15	0.30	0.40	0.55	0.00	0.05	0.30	0.00
12	22 March 21	1.45	2.45	1.55	0.55	0.50	0.45	0.00	0.10	0.50	0.05
13	29 March 21	1.45	2.60	1.65	0.25	0.35	0.45	0.00	0.15	0.40	0.10
14	05 April 21	0.90	1.10	1.50	0.55	0.30	0.30	0.30	0.05	0.45	0.40
15	12 April 21	1.25	1.90	1.35	0.65	0.35	0.85	0.80	0.05	1.00	0.25
16	19 April 21	0.90	1.10	1.50	1.50	1.50	0.70	1.05	0.00	0.85	0.20
17	26 April 21	0.60	1.20	1.05	1.05	0.55	0.70	0.85	0.10	0.50	0.10
18	03 May 21	0.75	1.35	1.10	1.20	0.35	0.55	0.80	0.05	0.45	0.00
19	10 May 21	0.65	0.85	0.80	1.15	0.30	0.35	0.45	0.00	0.40	0.00

Note: *mean value of five plants

Conclusion

The present experiment entitled was undertaken at the Experimental Farm, New colony, Ward 7, Chumukedima, Dimapur, Nagaland from February to May 2021 with the objectives to study the pest complex of chilli and natural enemies. The field trial was conducted in a Randomized Block Design (RBD) with five treatments including control as the main factor and pests complex and correlation coefficient of major insect pests and natural enemies with abiotic factors as minor factor. The data thus obtained were subjected to suitable and appropriate statistical analysis as per the requirement of the design. The experimental findings of the present investigation are summarized as follows:

- During the course of investigation, eight insect pests belonging to 5 orders and 8 families were recorded infesting chilli, aphids, *Aphis gossypii* Glover (*Hemiptera: Aleyrodidae*), whitefly, *Bemisia tabaci* Gennadius (*Hemiptera: Aleyrodidae*), mites, *Polyphagotarsonemus latus* Banks (*Araci: Tarsonemidae*), mealy bugs, *Pheanacoccus solenopsis* Tinsley (*Hemiptera*: *Pseudococcidae*), leaf feeders pests like thrips, *Scirthothrips dorsalis* Hood (*Thysanoptera: Thripidae*), jassids, *Amrasca biguttula* Ishida (*Hemiptera*: *Cicadellidae*), grasshopper, *Omocestus viridulus* Linnaeus (*Orthoptera: Acrididae*) was appeared from vegetative stage till harvest. Fruit feeders like fruit borer, *Helicoverpa armigera* Hubner (*Lepidoptera*: *Noctuidae*) was appeared from fruit formation stage. Two natural enemies Coccinellids, *Coccinella transversalis* Fabricius (*Coleoptera: Coccinellidae*), and Preying mandits, *Mantis religiosa* Linnaeus (*Mantodea: Mandidae*) were also observed during the course of study.
- Among them, incidence of aphids, whitefly, thrips and fruit borers were observed to be the important pests while others were negligible.
- The incidence of aphids, *Aphis gossypii* was observed initially in the field at 6th standard mean week (8th February).
- The highest population of aphids was recorded at 11th SMW (15th March) and 12th SMW (22nd March) with mean population of 1.60 aphids/ plant and 1.45 aphids/ plant respectively. The lowest population was observed at 6th SMW (8th February) with 0.60 aphids/ plant.
- The incidence of whitefly (*Bemisia tabaci* Gennadius) and thrips (*Scirthothrips dorsalis* Hood) was observed initially in the field at 6th standard mean week (8th February).
- The highest whitefly population was observed at 13th SMW (29th March) with 2.60 whiteflies/ plant. The lowest population was observed at 19th SMW (10th May) with 0.85 whiteflies/ plant.
- The highest population of thrips (*Scirthothrips dorsalis* Hood) was recorded at 9th SMW (1st March) with 1.80 thrips/plant and the lowest was observed at 6th SMW (8th February) with 0.35thrips/ plant.
- The incidence of mealy bugs (*Pheanacoccus solenopsis* Tinsley) was observed initially in the field at 9th SMW (1st March).
- The highest population of mealy bugs was recorded at 16th SMW (19th April) with 1.50 mealy bugs/ plant and the lowest population was recorded at 9th SMW (1st March) with 0.10 mealy bugs/ plant.
- The incidence of fruit borer (*Helicoverpa armigera* Hubner) was observed initially in the field at 14th SMW (5th April).
- The highest population of fruit borers was recorded at 16th SMW (19th April) with 1.05 fruit borers/ plant and the lowest population was recorded at 14th SMW (5th April) with 0.30 fruit borers/ plant.
- The incidence of coccinellids (Coccinella *transversalis* Fabricius) was observed initially in the field at 6th SMW (8th February).
- The highest population of coccinellids was recorded at 15th SMW (12th April) with 1.00/ plant and the lowest

was observed at 6th SMW (8th February) with 0.15/plant.

The finding of the present investigation provides important information about the pest complex and natural enemies of chilli, their incidence and correlation with abiotic factor and their management. The finding of this present study also provides information in the ecofriendly and sustainable management of the pests of chilli using available botanicals and microbial agents. This information will be useful in conducting future research on this particular crop as well as in the management of the pests.

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