Seasonal activity and diversity of insect fauna collected through light ~~trap~~ traps in protected and unprotected conditions during *rabi* season

Abstract

The present investigation was carried out by installing two light traps with different light sources in the experimental site one is inside the polyhouse and the other is outside the polyhouse. Insects were collected regularly from the third week of September 2019 to the second week of March 2020. During the study, in all, 8 predaceous and 6 harmful species were observed in the light trap inside the polyhouse. Seven major insect pest species and some unidentified Lepidopteran moths were identified and collected outside the polyhouse~~,~~ as important positively phototropic insect pests in rabi crops. The light sources used in light trap SMV-4 models were 8+8 watt UV (10"tubes) and 15 watt UV (15" tube).

Key words: Insect Fauna, Light trap, Poly house, Protected condition, Solar trap, UV

1. Introduction

Traps are used for general ~~survey~~ surveysof insect diversity and usually are simple interception devices that ~~attracts~~ attractand capture insects moving through an area. Traps also are used for the detection of new invasions of insect ~~pest~~ pestsin time and space, for delimitation of ~~area~~ areasof infestation, and for monitoring population levels of established pests. Light trap helps to minimize the pest population by mass trapping ~~of~~ reproducing adults of both ~~the~~ sexes from the crop ecosystem. It is absolutely an eco-friendly approach ~~of~~ toinsect pest management [1-2]. In areas~~,~~ where organic farming is a common practice and using~~use of~~ insecticides is prohibited (by law), it is the only available practical method of pest control to minimize ~~the~~ crop losses due to insect pests effectively without ~~the use~~ usinginsecticides. Environmental conditions inside the polyhouse/ greenhouse can be modified to suit~~ingto~~ the potential growth of plants. Partial control of microclimatic conditions, which have major influence on plant growth characteristics, can be achieved in poly greenhouses [3]. The growing conditions within the protected environment of the greenhouse/ polyhouse are highly favorable to arthropod pests. In India, about twenty insect and mite species have been recorded to be associated with the crops under protected environment [4-5].

Seasonal activities of insect pest species can be monitored very effectively through trap catches. Conducted a study to collect valuable information on the seasonal activity of four major insect pest species, namely white backed plant hopper, rice leaf folder, ~~army worm~~armyworm grasshopper (complex) and other insect pest species of paddy [6], and to find out ~~its~~ theirrelationship with weather parameters [7]. Used Ultra-violet light traps for insect capture and found that Coleopterans dominate the catches followed by Hemipterans [8], Hymenopterans, and Lepidopterans. ~~Low~~ The lowwattage of ~~ultra violet~~ultraviolet (~~Black light~~Blacklight) lamps 8 and 15 ~~watt~~ wattswith low electricity consumption, maintaining high trapping efficiency, makes these lamps most convenient to operate the light traps with a solar panel or a set of dry recharging batteries, even in remote areas in the farmer's field where electricity is not available [9]. Findings ~~of~~ suggest that highly toxic wavelengths of visible light are species-specific in insects[10], and that shorter wavelengths are not always more toxic. Blue light is more harmful than UV light for some animals, such as insects~~For some animals, such as insects, blue light is more harmful than UV light~~.

Comment [HNL1]: These names are common names but might not be at the same taxonomic level (species or species groups). So, it is better to provide the scientific names of these pests.

Comment [HNL2]: This sentence has no subject. Please revise it.

2. Materials and Methods

The experiments were conducted in JNKVV campus, Jabalpur (MP) during the period between third week of October to third week of March, (2019-2020~~). Light~~). Light Trap model SMV-4 (UV 8+8w) was used inside the polyhouse and model SMV-4 (UV 15w) were used in open field for the monitoring of insect pest. Light traps were operated every night and collection was being observed next morning. Observations were recorded every day throughout the *rabi* season. Total insect fauna was observed and sorted out based on major species and order groups. Data of daily trap catch was maintained. Weekly records of day to day catches were maintained order, family and species wise. In all, two light traps were installed in the experimental area. The area was covered mainly by a gram around 5 hectors of crop area outside the polyhouse and tomatoes were grown inside the polyhouse. Spacing between two traps was approximately 300 meters. The data of every day catch of major insect pests collected in trap were converted to weekly total (corrected to seven days).

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3. Result and Discussion

3.1. Seasonal activity and diversity of insect fauna collected through light trap in protected condition (polyhouse)

Results of the experiment on seasonal activity and diversity of insect fauna collected through a light t~~T~~rap in polyhouse using UV (8+8 watt) light source 12" t~~T~~ube length as a light source are described in brief below: Seasonal activities of insect fauna (Table no. 1) collected in the light trap were studied by operating light trap with UV ~~8+8 watt~~8+8-watt

light source. The experiment was conducted in a polyhouse at Krishi Vigyan Kendra, JNKVV Jabalpur (MP), during the period between the third week of September to the second week of March, (2019 -2020). ~~Tomato~~ The tomatowas the ~~princip~~principal~~le~~ crop grown inside the polyhouse and in the~~in~~ light trap area ~~which was~~ installed at the centre of the polyhouse. The data in Table. No.1 and 2 showing seasonal activity of beneficial and harmful insects, respectively. In all, 14 species of insects were observed in the crop ecosystem, having regular occurrence in light trap catches. Of the 14 species recorded, 6 species were harmful, and 8 were beneficial. It was found that the beneficial insects (58.99%) were more abundant than the harmful insects (41%) [11,12]. ~~In the present study it was~~The present study found that Coleoptera is the most diverse insect order in the polyhouse ecosystem, followed by Orthoptera.

The species of Carabidae among the predaceous Coleoptera were more active compared to other groups, and the Reduviid bugs were the least responsive ~~one~~. In accordance with the present findings~~,~~[13] , ~~also observed~~21 predaceous and 8 parasitic species of insects were observed and collected in the light trap at Jabalpur. Species of Carabidae and Cicindelid among the predacious Coleoptera and Reduviid among the Hemiptera were, however, the most responsive, but Coccinellidae (Coleoptera)~~s~~ were the least responsive to light which is in contrast with the current findings. Coccinellids were observed in significantly high number in the present study.

Comment [HNL4]: You can simply write "predaceous Carabidae (Coleoptera)".

Comment [HNL5]: Did you mean "previous"? In my opinion, "present" is often used to mention something from this study. Please clearly distinguish the two terms to avoid unnecessary misunderstanding.

Comment [HNL6]: Cicindelidae (Coleoptera)

Comment [HNL7]: Reduviidae (Hemiptera).
I think it is better to write the scientific names of these insect families. Cicindelid = Cicindelidae (Coleoptera); Coccinellid = Coccinellidae (Coleoptera); Reduviid = Reduviidae (Hemiptera), etc.
Cicindelid, Coccinellid, and Reduviid are not wrong, but they are some kinds of common names. In a scientific article, using scientific names is more professional.

Table 1: Seasonal activity of beneficial species collected during September to March 2019-20.

Observation period weekly	*Chlaeniuscircumdatus*	*Ophioneaindica*	*Coccinellaseptumpunctata*	*Dytiscusmarginalis*	*Brachinuslongipalpis*	*Chlaeniusnigricans*	*Chlaeniusmedioguttatis*	*Sirtheneacarinata*
Sept III wk	**00 (0.71)**	**00 (0.71)**	**25 (5.05)**	**40 (6.36)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**
Sept IV wk	**12 (3.54)**	**00 (0.71)**	**26 (5.15)**	**36 (6.04)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**
Oct I wk	**15 (3.94)**	**00 (0.71)**	**20 (4.53)**	**23 (4.85)**	**00 (0.71)**	**01 (1.22)**	**00 (0.71)**	**00 (0.71)**
Oct II wk	**12 (3.54)**	**21 (4.64)**	**16 (4.06)**	**18 (4.30)**	**00 (0.71)**	**01 (1.22)**	**00 (0.71)**	**00 (0.71)**
Oct IIIwk	**24 (4.95)**	**13 (3.67)**	**09 (3.08)**	**21 (4.64)**	**00 (0.71)**	**00 (0.71)**	**03 (1.87)**	**02 (1.58)**
Oct IV wk	**19 (4.42)**	**04 (2.12)**	**03 (1.87)**	**16 (4.06)**	**02 (1.58)**	**02 (1.58)**	**00 (0.71)**	**00 (0.71)**
Nov I wk	**12 (3.54)**	**04 (2.12)**	**01 (1.22)**	**12 (3.54)**	**02 (1.58)**	**02 (1.58)**	**02 (1.58)**	**01 (1.22)**
Nov II wk	**07 (2.74)**	**03 (1.87)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**
Nov III wk	**01 (1.22)**	**01 (1.22)**	**00 (0.71)**	**03 (1.87)**	**01 (1.22)**	**01 (1.22)**	**00 (0.71)**	**00 (0.71)**
Nov IV wk	**04 (2.12)**	**00 (0.71)**	**00 (0.71)**	**01 (1.22)**	**01 (1.22)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**
Dec I wk	**04 (2.12)**	**00 (0.71)**	**00 (0.71)**	**02 (1.58)**	**01 (1.22)**	**00 (0.71)**	**01 (1.22)**	**00 (0.71)**
Dec II wk	**02 (1.58)**	**01 (1.22)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**01 (1.22)**	**01 (1.22)**	**00 (0.71)**
Dec III wk	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**
Dec IV wk	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**
Jan Iwk	**02 (1.58)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**

Jan II wk	**01 (1.22)**	**02 (1.58)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**
Jan III wk	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**
Jan IV wk	**04 (2.12)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**04 (2.12)**	**00 (0.71)**	**01 (1.22)**	**00 (0.71)**
Feb Iwk	**06 (2.55)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**05 (2.35)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**
Feb II wk	**02 (1.58)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**
Feb III wk	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**
Feb IV wk	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**
March Iwk	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**
March IIwk	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**
Total	**127(48.44)**	**49 (29.8)**	**100(37.03)**	**172(48.4)**	**16(23.36)**	**07(20.82)**	**08(20.6)**	**03(18.42)**

Value in parenthesis is square root transformation value (SQRT)

Table 2: Seasonal activity of insect-pests collected during September to March 2019-2020

Observation period weekly	*Forficulaauricularia*	*Riptortusstrenuus*	*Gryllusbimaculatus*	*Cofana spectra*	*Flata sps.*	*Spodoptera litura*
Sept III wk	**00 (0.71)**	**00 (0.71)**	**20 (4.53)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**
Sept IV wk	**00 (0.71)**	**00 (0.71)**	**31 (5.61)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**
Oct I wk	**16 (4.06)**	**00 (0.71)**	**33 (5.79)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**
Oct II wk	**04 (2.12)**	**16 (4.06)**	**27 (5.24)**	**00 (0.71)**	**01 (1.22)**	**00 (0.71)**
Oct III wk	**04 (2.12)**	**17 (4.18)**	**25 (5.05)**	**02 (1.58)**	**10 (3.24)**	**00 (0.71)**
Oct IV wk	**06 (2.55)**	**14 (3.81)**	**17 (4.18)**	**01 (1.22)**	**02 (1.58)**	**00 (0.71)**
Nov I wk	**02 (1.58)**	**14 (3.81)**	**08 (2.92)**	**02 (1.58)**	**01 (1.22)**	**03 (1.87)**
Nov II wk	**01 (1.22)**	**04 (2.12)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**01 (1.22)**
Nov III wk	**03 (1.87)**	**05 (2.35)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**03 (1.87)**
Nov IV wk	**00 (0.71)**	**01 (1.22)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**02 (1.58)**
Dec I wk	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**07 (2.74)**
Dec II wk	**00 (0.71)**	**01 (1.22)**	**01 (1.22)**	**00 (0.71)**	**00 (0.71)**	**05 (2.35)**
Dec III wk	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**03 (1.87)**
Dec IV wk	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**
Jan Iwk	**00 (0.71)**	**00 (0.71)**	**02 (1.58)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**
Jan II wk	**00 (0.71)**	**00 (0.71)**	**04 (2.12)**	**00 (0.71)**	**00 (0.71)**	**02 (1.58)**
Jan III wk	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**02 (1.58)**
Jan IV wk	**00 (0.71)**	**00(0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**01 (1.22)**
Feb Iwk	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**01 (1.22)**
Feb II wk	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**03 (1.87)**
Feb III wk	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**01 (1.22)**
Feb IV wk	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**
March Iwk	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**
March IIwk	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**00 (0.71)**	**06 (2.55)**
Total	**36 (27.55)**	**72 (34.09)**	**168 (48.15)**	**05 (19.24)**	**14 (21.41)**	**40 (31.83)**

Value in parenthesis is square root transformation value (SQRT)

Family: Carabidae (Coleoptera): The beetles are predominantly predaceous. Both in the larval and adult stage

1.*Chlaeniuscircumdatus*Brullé: It is a general predator of caterpillars ~~and~~ with~~soft bodied~~soft-bodied insects.The insect was active from the IV week(wk)of September to the ~~February~~ II week of February.

Comment [HNL8]: If you want to use the term "wk" as the following, please add the explanation of the abbreviation.

2.*Ophionea indica* Thunberg: It is an ~~important~~ essential predator of ~~nymph~~ nymphsand adults of brown plant hopper. Both the grubs and adults of the carabid beetle are reported as ~~predator~~predators. The insect was active from 2nd week of October to 4thweek of November.

3.*Brachinuslongipalpis*Wiedemann*:* The insect (general predator) was active from the last week of October. ~~Population~~ The populationdeclined from Nov II wk to Jan III wk, then population reached at peak at Jan IV wk and ~~Feb I~~Feb I wk.

4. *Chlaenius nigricans* Wiedemann: Predaceous upon *Laphgmapyraustanubilalis* and *Pinusinsiguos sp*. The larvae feed exclusively on amphibians. The adult beetles are ~~generalize~~generalizing predators. The insect was active from the first week of October to Nov II week.

5. *Chlaeniusmedioguttatis*Chaudoir: It is a general predator of lepidopterous larvae. The insect activity started from October III wk with a peak of 3. Activity started in Oct I wk and slightly increases ~~at in~~Oct IV wk. ~~Population~~ The populationstarted declining from Nov I wk onwards, and no activity was observed then.

Family: Coccinellidae(Coleoptera)

6. *Coccinellaseptumpunctata*Linn: Coccinellids are best known as predators of aphids and scale insects. Species are significant predators of the eggs and larvae of moths, such as species of *Spodoptera* (Lepidoptera: Noctuidae)and the Plutellidae. The insect activity started from Sept III wk till Nov I wk~~.~~, and then no activity was observed.

Family: Dytisadae(Coleoptera)

7. *Dytiscusmarginalis*Linnaeus: They are the predaceous diving beetles. Scavenger beetles will feed on decomposing organic material that has been deposited. The ~~insects~~ insects'activity ~~were~~ started from Sept III wk till December I week.

~~**3.1.4. Family: Reduviidae (Hemiptera: Heteroptera):** The Reduviidae are members of the suborder Heteroptera of the order Hemiptera.~~ The nymphs and adults of ~~family members~~Reduviidae are almost ~~all predatory. They are~~ general predators and ~~. Nymphs and adults of most species are~~ predatory upon other insects.

8. *Sirtheneacarinata*Fabricius: *Sirthenea* is one of the genera included and is exceptional in ~~being~~ subterranean. *Sirtheneacarinata* is a generalist predator of mole crickets. ~~Insect~~ The insectwas active during the season from October III wk to November I wk.

Family:Coriedae (Hemiptera): Most hemipterans are phytophagous, using their sucking and piercing mouthparts to feed on plant sap. These include leafhoppers, plant hoppers, aphids, whiteflies, scale insects, and some other groups. Some are monophagous, being host

Comment [HNL9]: When writing the scientific name of a species, the name should be in Italic format, but the reference (author name, year) must be in normal format.

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Comment [HNL12]: Check it.

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Comment [HNL15]: What did you mean?

Comment [HNL16]: Revise these sentences. Is this species active from 1st week or 3rd week of Oct?

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Comment [HNL18]: It is not parallel. *Spodoptera*is a genus, Plutellidae is a family. Let give some genera of Plutellidae as examples.

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specific and only found on one plant taxon~~, others~~. Others are oligophagous, feeding on a few plant groups, while others again are less discriminating polyphagous and feed on many species of plant.

9. *Riptortusstrenuus*Fabricius:Pest was active during the season from October II wk to December II wk. ~~Activity~~ The activitystarted in October II wk. Initially, no activity was seen from September III wk to October I wk. ~~Population~~ The populationreached ~~at~~ its peak in October III wk with t catch of 17. Then the population started declining from November IV wk onwards and becomes zero.

Family Cicadellidae (Hemiptera)

10. *Cofana spectra* (Distant): The white leafhopper (WLH) *Cofana spectra* is a pest~~,which suck~~ sucking sap from the leaves and results drying of leaf tips leading the leaf tip to orange and curl. Pest was active during the season from October III wk to November I wk.

Family Flatidea (Hemiptera)

11. Flata sp. Fabricius: Pest of various crops. Pest was active during the season from October II wk to November I wk.

Family Forficulidae (Dermaptera)

12. *Forficulaauricularia*Linnaeus:The European earwig (*Forficulaauricularia*) can be quite common in greenhouses. Earwigs are nocturnal and feed on a variety of things, including plants and other insects. Earwigs have occasionally become a problem in greenhouse crops by moving into the crop canopy and damaging fruit. Pest was active during October I wk to November III wk.

Family Gryllidae (Orthoptera)

13. *Gryllusbimaculatus*~~,~~(De Geer):Field cricket is an opportunistic scavenger and will feed on a variety of organic ~~material~~materials. In greenhouses, it is known to damage young plants. Pest was active during the season from September III wk to January II wk.

Family Noctuidae (Lepidoptera)

14. *Spodoptera litura*~~,~~(Fabricius):*S.litura* also ~~cause~~ causesconsiderable damage in some polyhouses. It is a polyphagous pest and has been reported to do ~~serious~~ severedamage as a foliage feeder in crops like groundnut, tomatoes, cabbage, cauliflower, and many Kharif pluses like moong, urd, and soybean. Leaf defoliator and also damages fruits. Pest was active during the season from November I wk to March II wk. ~~Activity~~ The activitystarted from November I wk. Population showed a ~~highest peak of 7 in December I wk and again of~~ peak of 7 in December I wk and 6 in March II wk. Initially, no activity was seen from September III wk to October IV wk.

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3.2. Seasonal Activity and Diversity of Insect Fauna Collected through Light Trap in Unprotected Condition (Outside Polyhouse)

Major insect pest species of Rabi crops (Table no.3) collected in light trap were studied by operating light trap with SMV-4 15watt UV light sources. The trap was installed behind the biotechnology center, JNKVV campus. Seven insect pest species, namely Gram pod borer *Helicoverpaarmigera*, Black cutworm *Agrotisipsilon*, Tiger moth *Creatonotosgangis*,Field cricket *Gryllusbimaculatus*,Mole cricket *Gryllotalpa orientalis*,Cabbage semilooper *Plusiaorichalcea*,Unidentified Lepidoptera moth were identified as important positively phototropic insect pest in rabi crops. Chickpea was the ~~principle~~ principalcrop grown on the farm in the light trap area. Record of daily collection of insect species of rabi crops based on our experience occurring regularly throughout the season was maintained. The data of every day ~~catch~~ catchesof major insect pest collected in the trap were converted to weekly total (corrected to seven days)[14-15]. Species wise description of trap catches is given in Table No.3, and the seasonal activity is given in Table No.4

Table No. 3: Important positively phototropic insect pest collected in the light trap

S. N	Common name	Scientific name	Order	Family
1.	Gram pod borer	*Helicoverpaarmigera*	Lepidoptera	Noctuidae
2.	Black cutworm	*Agrotisipsilon*	Lepidoptera	Noctuidae
3.	Tiger moth	*Creatonotosgangis*	Lepidoptera	Noctuidae
4	Cabbage semilooper	*Plusiaorichalcea*	Lepidoptera	Noctuidae
5	Feild cricket	*Gryllusbimaculatus*	Orthoptera	Gryllidae
6	Mole cricket	*Gryllotalpa oreintalis*	Orthoptera	Gryllotalpidae
7	Unidentified Lepidoptera moth	Miscellaneous species	Lepidoptera	-----

Table No. 4: Seasonal activityof insect pest species collected in light trap (Model SMV-4 UV 15 watt)

S. No.	Observation period weekly	Species wise mean per day per trap						
		Helicoverpaarmigera	*Agrotisipsilon*	*Creatonotosgangis*	*Plusiaorichalcea*	*Gryllusbimaculatus*	*Gryllotalpa oreintalis*	Unidentified Lepidoptera moth
1	Oct III wk	0	0	19	0	12.8	0.5	5.94

2	Oct IV wk	0	0	16.05	0	7.46	0.11	6.10
3	Nov I wk	0	0	6.5	0	3.14	0.79	2.28
4	Nov I wk	0	0	4.43	0	2.07	1.93	1.14
5	Nov III wk	0	0	7.69	0	1.57	3.64	3.14
6	Nov IV wk	0	0	6.67	0	1.0	3.20	5.25
7	Dec I wk	0	0	6.78	0	0.86	2.22	7.22
8	Dec II wk	0	0	4.10	0	0.65	2.28	4.72
9	Dec III wk	0	0	2.94	0	0	1.57	4.5
10	Dec IV wk	0.20	0.30	1.42	0	0.36	0.74	3.66
11	Jan I wk	0.14	0.20	1.36	0.79	0.72	0.57	2.72
12	Jan II wk	0.12	0.10	1.36	0.64	0.72	0.36	1.29
13	Jan III wk	0.14	0.11	1.69	1.36	0.43	0.59	1.77
14	Jan IV wk	0.14	0.57	1.06	0.81	1.18	0.94	5.45
15	Feb I wk	0.14	0.29	1.36	0.64	0.43	0.57	3.71
16	Feb II wk	0.22	0.79	1.29	0.43	0.86	0.14	2.86
17	Feb III wk	0.29	0.7	0.85	1.15	0.43	0.41	3.43
18	Feb IV wk	0.65	1.10	2.93	2.96	0.29	0.64	6.83
19	Mar I wk	0.71	1.93	6.71	2.65	1.14	1.07	9.0
20	Mar II wk	0.86	1.50	6.93	2.07	1.43	1.64	7.86
21	Mar III wk	1.5	1.42	7.14	1.29	1.86	1.0	8.92

1. Gram pod borer (*Helicoverpaarmigera*): It is a major polyphagous pest of pulses, potato, tomato, ~~chilli~~chili, and okra crops in Jabalpur. December to March was the active period with two peaks in population.

2. Field cricket (*Gryllusbimaculatus*): Field crickets are known to damage many cultivated crops as soil ~~pest~~ pests~~damaging roots~~. Pest was active throughout the rabi season from the standard week (SW) 43 to SW11.

3. Mole cricket (*Gryllotalpa orientalis*): Very little is known about the status of these species as a pest of agricultural crops. Mole cricket is known to damage many cultivated crops as a soil pest. ~~Pest~~ The pest was active from SW 43 to SW 11 wk.

4. Tiger moth (*Creatonotosgangis*): ~~Pest~~ The pestwas active throughout the rabi season from October (2019) to March 2020. ~~Population~~ The populationstarted at its peak in SW 43 and declined sharply in SW 2.

Comment [HNL20]: Why did you use the common name of these species in this section but not use the common name of species in the Section 3.1?

Comment [HNL21]: Please ensure the consistency of your article. The format of this section is different from the section 3.1.

5. **Cabbage ~~semilooper~~ semi looper*Plusiaorichalcea*:** It is a ~~major~~ significantpest of vegetable crops in Jabalpur. Activity during January was slightly started. It is seen that after the appearance of adult moths in trap catches during SW I, a slight increase and decrease trends ~~was~~ wereobserved from SW II to SW 10. Population trend in seasonal activity~~,~~ showed a peak appearing in SW 8~~,~~.

6. Cutworm *Agrotisipsilon*(Hufnagel): It is a major polyphagous pest of pulses and vegetable crops ~~like~~ such as cabbage, cucurbits, and potato in Jabalpur as per the earlier records, but this year, the activity of this pest was very low. ~~Cutworm~~ Cutwormsfirst appeared during SW IV in the light trap. It is seen that after the appearance of moths in trap catches during SW 4, with a slight drop in catches during SW II, it further increased and reached ~~to~~ its highest peak during SW 9 (17 moths). Population trend in seasonal activity~~,~~ showed only one peak appearing in SW 9.

7. Unidentified Lepidoptera Moth: These ~~Moths~~ moths ~~was~~ wereactive throughout the rabi season from SW 43 to SW 11. ~~Activity~~ The activitystarted in SW 43. ~~Population~~ The populationreached ~~at~~ its first peak in SW 44 and declined sharply in SW 2. In the SMV-4 light source, peak was distinctly higher (78 moths).

The activity of the noctuids*Helicoverpaarmigera* (Hubner), *Agrotisipsilon* (Hufnagel), and *Thysanoplusiaorichalcea* (Fabricius)~~,population~~ populationsremained low during December, January and February [16]. March and April was a period of very high activity for all species. Observed that *H. armigera* were most abundant in late summer [17]. Similar trends were apparent for catches of both male and female *H. armigera* in light traps. He also recorded correlations between autumn and winter rainfall in central Australia. Recorded the same pattern with MV light source [18].

Observed the light trap catches of cabbage semilooper *Plusiaorichalcea* during ~~the period~~ 1991-92 and 1992-93 Rabi ~~season~~ seasonsat Varanasi~~,~~ and analyzed for various characters [19]. The activity of ~~pest~~ pestswas low to medium in January and February (monthly catch-34 and 277 moths). Population suddenly raised to a very high level in March (64,566 moths).

4. Conclusion

In conclusion, the data collected and observed shows that since the percentage of beneficial species ~~are~~ ismore compared to harmful species~~.,Ii~~f light traps are operated selectively, avoiding the period from September to February, the fauna of the beneficial species group will not be affected much. Seasonal activity of 7 species of insect pests, which were observed in ~~traps~~ trapcatches operated in the field (rabi crop) regularly in considerable

Comment [HNL22]: The format of this part is different from the previous part (inside polyhouse).

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~~number~~ numbers, ~~were~~ was ~~studies~~ studied in the rabi season during the period 3rd week of October (2019) to 3rd week of March (2020). Two to three peaks were ~~observed in general~~ generally observed, showing ~~period~~ periods of highest ~~&~~ and lowest activity in both.

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Comment [HNL23]: Please provide URLs of references.
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