

A Comparative Study of Insect Collection Made by Employing Two Different Methods of Collection in an Agro-Ecosystem near Jhunjhunun, Rajasthan, India

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Abstract: As insects play many different roles in an ecosystem, it is important to know their diversity and density in a particular area and also during specific seasons. Deciding which insect trap to use is an important consideration for ecologists and entomologists. During the present study, the relative performances of cage net trap and light trap have been compared for insect collection. The study was undertaken in an agro-ecosystem situated in the Indian desert in Jhunjhun district situated in western Rajasthan. Insects visiting different crops cultivated round the year were collected employing an indigenously designed cage of size 1mx1mx1m of nylon mesh during day time and light trap comprising of 260 Watt mercury bulb during night. The cage net trap collection comprised of fifteen coleopteran, thirty one lepidopteran, fourteen hemipteran, twenty two hymenopteran, eight dipteran, three dictyopteran, nine orthopteran, five odonates, one neuropteran and one embiopteran, while in light trap collection order Coleoptera was represented by fifteen species, order Lepidoptera by twenty species, order Hemiptera by seven species, order Hymenoptera by three species, order Diptera by three species, order Dictyoptera, Embioptera and Orthoptera by one species each and order Neuroptera by three species. No odonates were observed in light trap collection. Further, the light trap collection comprised of four species which were never documented in cage net collections.

Keywords: Insects, Cage net, Light trap, Agro-ecosystem

1. Introduction

Ecologically, insects play many different roles as pests, predators and parasites, pollinators, decomposers and scavengers and so forth. It is therefore important to know their diversity and density in a particular area and also during specific seasons. But, it seems that few such studies have been conducted, one major limitation being the lack of consensus on methods for insect collection. Deciding which insect trap to use is an important consideration for ecologists and entomologists. During the present study, the relative performances of cage net trap and light trap have been compared for insect collection. The study was undertaken in an agro-ecosystem situated in the Indian desert in Jhunjhun district situated in western Rajasthan.

2. The Study Area

The state of Rajasthan is the largest state of Indian republic located between 23°3' to 20°13' N latitude and 69°30' to 78°17' E longitudes. The study area in the form of an agricultural field is located at 28°08'N, 75°24' E and 28.13°N 75.4°E having an average elevation of 323 m (1059 feet) in the district of Jhunjhun. The agro-ecosystem in the form of crop fields studied lies about 5km away from the city of Jhunjhun, covering an area of 1000 x 500 m.

3. Methodology

The study concentrated on comparing the diversity and density of insect visitors to different crops cultivated round the year employing an indigenously designed cage of size 1mx1mx1m of nylon mesh for insect collection during day

time and light trap comprising of 260 Watt mercury bulb was employed for collecting the nocturnal insect species. The insect visitors were surveyed and collected every week from October 2010 to April 2011. For the study, the field area was divided into five stations. The insects collected by the above method were transferred to killing bottles, killed and preserved. The fauna were sorted out and help from the Section of Entomology, Department of Agriculture, Bikaner and Desert regional Station of the Zoological Survey of India, Jodhpur was also taken for identification and for confirmation. Besides, the reference collection in the Department of Zoology, Dungar College was also consulted.

4. Result

During the present survey, insects were collected employing cage net and light trap. The diversity of insects as observed in the collection made by employing these two methods has been presented in Table 1.

The cage net trap collection comprised of fifteen coleopteran, thirty one lepidopteran, fourteen hemipteran, twenty two hymenopteran, eight dipteran, three dictyopteran, nine orthopteran, five odonates, one neuropteran and one embiopteran, while in light trap collection order Coleoptera was represented by fifteen species, order Lepidoptera by twenty species, order Hemiptera by seven species, order Hymenoptera by three species, order Diptera by three species, order Dictyoptera, Embioptera and Orthoptera by one species each and order Neuroptera by three species. No odonates were observed in light trap collection. Further, the light trap collection comprised of four species which were never documented in cage net collections.

Of the total 113 species (10 orders) collected through cage net and light trap, 56 were considered dominant, 26 as frequent, while, 31 as rare forms.

The dominant species included *Anomala bengalensis*, *Onthophagus catta*, *O. bonasus*, *Adoretus* sp., *Ochodeus* sp., *Peltonotus nasutus*, *Apogonia ferruginea*, *Cylindrothorax pictus*, *Coccinella septempunctata*, *Menochilus sexmaculatus*, *Cicindella* sp., *Myllocerus* sp. and *Hypolixus truncatulus* belonging to order Coleoptera; *Danaus chrysippus*, *Colotis vestalis*, *C. fieldii*, *Eurema hecabe*, *Lampides boeticus*, *Hymenia recurvalis*, *Cnaphalocrocis medinalis*, *Earias insulana*, *Mythimna separata*, *Agrotis ipsilon*, *Chrysodeixis chalcites*, *Thysanoplusia orichalcea*, *Heliothis peltigera*, *Sphenarches caffer*, *Etiella zinckenella*, *Utethesia pulchella*, and *Tephрина* sp. belonging to order Lepidoptera; *Nezara viridula*, *Bagrada hilaris*, *Piezodorus* sp., *Dysdercus cingulatus* and *Lipaphis erysimi* belonging to order Hemiptera; *Xylocopa fenestrata*, *X. violacea*, *Apis cerana*, *A. mellifera*, *A. dorsata*, *A. florea*, *Dolichoderus affinis*, *Formica* sp., *Dorylus* sp., *Sceliphron brunneum* and *Enicospilus* sp. belonging to order Hymenoptera; *Musca domestica*, *Culex quinquefasciatus* and *Stichopogon* sp. belonging to order Diptera; *Chrotogonus* sp., *Ochridia* sp., *Oxya chinensis*, *Acheta domesticus* and *Gryllus assimilis* belonging to order Orthoptera; *Bradinopyga geminata* belonging to order Odonata and *Chrysopa* sp. belonging to order Neuroptera.

The frequent species observed included *Melanotus* sp. belonging to order Coleoptera; *Junonia orithya*, *Cryptographis indica*, *Spodoptera exigua*, *Scirpophaga nivella*, and an unidentified species. A belonging to order Lepidoptera; *Aspongopus janus*, *Alcaeus* sp., *Andrallus spinidens*, *Oncocephalus* sp., *Dysdercus koenigii* *Aphanus* sp. *Clavigrella* sp. and *Pyrilla perpusilla* belonging to order Hemiptera; *Polistes* sp., *Delta* sp. and an unidentified species C belonging to order Hymenoptera; *Musca nibulo*, *Anthrax* sp., *Chrysomya megacephala* and *Chrysomya rufifacies* belonging to order Diptera; *Schistocerca gregaria* and *Euconocephalus* sp. belonging to order Orthoptera; *Pantala flavescens* and *Agriocnemis femina* belonging to order Odonata; *Oligotoma* sp. belonging to order Plecoptera and rare species included *Plocaederus* sp. belonging to order Coleoptera; *Acherontia styx*, *Catopsila pomona*, *Anaphaeis aurota*, *Papilio demoleus*, *Euchrysops cnejus*, *Leucinodes orbonalis*, *Hesperilla ornata*, *Pericallia ricini*, *Cretonotos gangis* and unidentified species. B belonging to order Lepidoptera; *Myzus persicae* belonging to order Hemiptera; *Amegila cingulata*, *Delta campaniforme*, *Eumenes fraternus*, *Athalia proxima*, *Chrysis dugesi*, unidentified species A, B, D and E belonging to order Hymenoptera; *Tabanus* sp. belonging to order Diptera; *Mantis religiosa*, *Deiphobe incis* and *Periplaneta americana* belonging to order Dictyoptera; *Acrida* sp. and unidentified species A belonging to order Orthoptera; *Rhodischnura nursei* and unidentified species A belonging to order Odonata; *Myrmeleon* sp. and *Ululodes quadrimaculatus* belonging to order Neuroptera during the period of study.

The cage net collection comprised of 109 insect species which have been presented in Table 2. The collection comprised of 15 coleopteran insect species of which 13 were

dominant, one frequent and one rare form; among 31 lepidopterans, 16 dominant, 4 frequent, and 11 rare forms; among 14 hemipterans, 5 dominant, 7 frequent and 2 rare species; among 22 hymenopterans, 10 dominant, 4 frequent and 8 rare species; among 8 dipterans, 3 dominant, 4 frequent and one rare form; 3 rare dictyopteran; among 9 orthopterans, 5 were dominant, 2 were frequent and 2 were rare forms; among 5 odonates only one was dominant while, 2 were frequent and 2 were rare forms; the single neuropteran species documented was dominant while, the single embiopteran species noted was a frequent form.

The 54 insect species documented in light trap collection which have been presented in Table 3. In light trap collection, 15 coleopteran species were observed of which 6 were dominant, 7 were frequent and 2 were rare forms; among 20 lepidopteran species only 2 were dominant, 11 frequent and 7 were rare forms: the 7 hemipteran species documented were all frequently observed; of the 3 hymenopterans, 2 were dominant and one was rare; among 3 dipterans, 2 were frequent and one was a rare form; one dictyopteran was rarely observed; one orthopteran was frequently observed; of the three neuropterans, one was frequent while, the other 2 were rare forms and the only embiopteran collected through light trap was a frequent form.

5. Discussion

During the present study most of the coleopterans, hymenopterans, dipterans (except mosquito), orthopterans (except *Acheta*) were noted in both type of collections, while members belonging to family Pieridae, Lycaenidae, Danaidae, Papilionidae and Nymphalidae of order Lepidoptera were observed only in cage collections, and certain neuropteran, *Dorylus* ant and a moth *Cretonotos gangis* were documented in light trap collections only. Density wise the number of different insects observed was always high in cage net as compared to light trap. Kundu *et al.* (1961) have also earlier studied the insect populations including Lepidoptera on light trap at Pilani (Rajasthan). A large number of species of butterflies and moths were found to be attracted towards the mercury lamps in Gujarat by Shull & Nadkerny (1964). Southwood (1966) observed that the size of light trap catch is influenced not only by the actual population of the adults present in the environment but also by the changes in the activity of the insects and their responsiveness towards the trap. Shull & Nadkerny (1967) and Nadkerny & Shull (1968) observed a large number of species of butterflies and moths attracted to the mercury vapour lamps in Gujarat. Brightness of moon was found to suppress the light trap catch in a number of noctuid species including *Heliothis* by Nema (1971), Persson (1971) and Agee *et al.* (1972). Coleopterans were found to be attracted more abundantly towards the light trap as compared to other insect orders by Pal & Sachan (1972). The highest catches (927) of *Rhinyptia meridionalis* through light trap were recorded by Pal (1977) when temperature and relative humidity ranged from 30 to 33°C and 52 to 65 per cent respectively. He further reported *Schizonychia ruficollis* on light from second fortnight of June coinciding with the onset of rainfall *Adoretos lesiophygus* highest during month of April, *Serica assanensia* during August and *Aserica* sp.

from June to September. Three weather factors viz., temperature, relative humidity and rain fall were studied to affect the flight activity and size of light trap catch of *Heliothis armigera* by Verma *et al.* (1982) at Jabalpur. The authors revealed that temperature and relative humidity had no significant effect on flight activity of insects and therefore no influence on trap catches while the trap catch on rainy days was considerably higher as compared to that before and after the rainy day. Vaishampayan & Verma (1982) studied the effect of moon light on light trap catches of *Heliothis armigera* by using mercury vapour lamp. The authors observed that in all the lunar cycles the trap catch was consistently very low on moonlit nights around full moon. They further suggested a significant linear and negative correlation between the degree of moon phase and light trap catches. Gregg *et al.* (1993) operated light traps on mountain tops during September to April in Australia and found that the catch consisted mostly of noctuid and sphingid species. The noctuid species included *Agrotis infusa*, *Mythimna convecta*, *Helicoverpa punctigera*, *Heliothis armigera*, *Dasygaster nephelistis* and *Agrotis munda* while sphingids mostly included *Hippotion scrofa*. Gregg *et al.* (1994) studied the catches of moths in tower mounted light traps in Northern New South Wales in relation to local and synoptic weather and found catches to be correlated with wind speed, relative humidity and rainfall. They further observed no correlation of catches with temperature but were found to be associated with wind shifts. Vaishampayan & Singh (1995) made studies using light trap on *Heliothis armigera* at Varanasi and revealed that the adult insects remain active during the period of December to May while during June to November the trap collection was either found to be nil or rare. Population status of some major pests of cotton crop such as *Amrasca biguttula biguttula* Ishida, *Spodoptera litura* (Fab.), *Helicoverpa armigera* (Hubner), *Earias spp.*, *Pectinophora gossypiella* (Saunders) and *Dysdercus cingulatus* (Fab.) was monitored by Murugesan *et al.* (2005) using 100w incandescent yellow and blue light traps during vegetative, flowering and boll development stages of cotton crops in a field at Sivakasi, South Tamil Nadu. The pests were surveyed and statistically analyzed with reference to lower rhythmic light, night mean temperature and rainfall. The number of insects trapped in full night collection of both the yellow blue light traps during new moon period was significantly higher than that during other lunar cyclical periods such as quarter, last quarter and full moon periods. The night catches were positively correlated with a unit change in night mean temperature of the survey days during vegetative stage and negatively correlated with that during flowering and boll developing stages of the cotton crops. Rainfall negatively influenced the catches of *A. biguttula biguttula*, *S. littura*, *Earias spp.* and *H. armigera* as well as positively influenced *P. gossypiella* and *D. cingulatus*. Moreover, the difference of crop damages in between the light trap region and shadow region was also analyzed and determined as factor for trapping efficiency of the light traps.

Bogush (1936) used light trap in determining the insect fauna and controlling the pests. Puttarudriah (1958) reported that the beetles are attracted towards light. Prasad & Thakur (1959) reported that the beetles are attracted towards light.

Vora & Ramakrishnan (1991) studied the phototactic response of *Holotrichia consanguinea*. The authors observed that the beetles *H. consanguinea* were positively phototactic towards lower intensity of light and both sexes were attracted to different colours of light. All these earlier studies give support to the present findings. From the present study conducted, it could therefore be concluded that the technique employed for insect collection is of great significance both for diversity as well as density comparisons.

References

- [1] Agee, H.R, Webb, J.C. and Toft, H.M. 1972. Activity of boll worm moths influenced by full moon. *Environ. Entomol.*, 1(3) : 384-385.
- [2] Bogush, P.P. 1936. Some results of a study of insects by means of a light trap in central Asia. *Bull.Ent. Res.*, 27:377-380.
- [3] Gregg, P.C., Fitt, G.P. Coombs, M. and Henderson, G.S. 1993. Migrating moths (Lepidoptera) collected in tower-mounted light traps in northern New South Wales. Australia: species composition and seasonal abundance. *Bull. Ent. Res.*, 83: 563-578.
- [4] Gregg, P.C.; Fitt, G.P. Coombs, M. and Henderson, G.S. 1994. Migrating moths collected in tower-mounted light traps in northern New South Wales, Australia: influences of local and synoptic weather. *Bull. Ent. Res.*, 84:17-30.
- [5] Kundu, H.L., Datta Gupta, A.K. and Gupta, B.B. 1961. A study of abundance of certain insects of Pilani (Rajasthan), with the help of a light trap. *Proc. Rajasthan Acad. Sci.*, 8(1&2): 79-87.
- [6] Murugesan, S., Murali, S. and Mahadevan, N.R. 2005. Influence of natural factors on the survey of insect pests of cotton crop in South Tamil Nadu using light traps. *Indian Journal of Entomology*, 67(1): 39-47.
- [7] Nadkerny, N.T. & Shull, E.M. 1968. Insects attracted to light in the Dangs, South Gujarat. *J. Bombay nat. Hist. Soc.*, 65(3):800.
- [8] Nemas, S.J. 1971. Effect of lunar phases on light trap catch and population of bollworm moths. *J.Econ. Ent.* 64(4): 860-863.
- [9] Pal, S.K. & Sachan, J.N. 1972. Studies on the relative abundance of photo-positive coleopterans at Central Arid Zone Research Institute, Farm, Jodhpur (Raj.) *Proc. Winter School (INSA) on development of Rajasthan Desert, C.A.Z.R.I. Jodhpur, February 12-18, 1973.*
- [10] Pal, S.K. 1977. Relative abundance of Scarabaeid beetles on light trap. *Indian J. Ent.*, 39(2): 197-200.
- [11] Persson, B., 1971. Influence of light on flight activity of Noctuids (Lepidoptera) in South Sweden. *Entomolo. Scand.*, 2: 215-232.
- [12] Prasad, S.K. & Thakur, C. 1959. White grub, *Lachnosterra consanguinea* Blanch, a new menace to sugarcane, *Indian J. Ent.*, 21(3): 324-325.
- [13] Puttarudriah, M. 1958. Glimpses of Agricultural Entomology in Mysore. *Agr. Coll Mag. Dharwar*, 11: 8-27.
- [14] Shull, E.M. & Nadkerny, N.T. 1964. Collecting moths by mercury vapour lamp in the Surat Dangs, Gujarat State. *J. Bombay nat. Hist. Soc.*, 64: 281-294.

- [15] Shull, E.M. & Nadkerny, N.T. 1967. Insects attracted to mercury vapour lamp in the Surat Dangs, Gujarat state. *J. Bombay nat. Hist. Soc.*, 64 (2): 256-266.
- [16] Southwood, T.R.E. 1996. Ecological methods. University Printing House, Methuen, London, 223 pp.
- [17] Vaishampayan, S.M. & Singh, H.M. 1995. Evidences on the ligratory nature of *Heliothis armigera* (Hubner) adults collected on light trap at Varanasi. *Indian J. Ent.*, 57(3): 224-232.
- [18] Vaishampayan, S.M. & Verma 1982. An influence of moonlight and lunar periodicity on the light trap catches on gram pod borer, *Heliothis armigera* (Hubner) moths. *Indian J. Ent.*, 44(3): 206-212.
- [19] Verma, R., Vaishampayan, S.M. and Rawat, R.R. 1982. Influence of weather factors on the light trap catch of gram podborer, *Heliothis armigera* (Hubner) moths. *Indian J. Ent.*, 213-218.
- [20] Vora, V.J. & Ramakrishnan, N. 1991. Attraction of the beetle, *Holotrichia consanguinea* Blanchard (Scarabaeidae : Coleoptera) to light and host plant. *Indian J. Ent.*, 53 (1): 45-49.

Table 1: Entomofaunal diversity observed in cage net and light trap collections separately during the period of study

Insect species	Cage net collection	Light trap collection
Order: Coleoptera		
Family: Scarabaeidae		
<i>Anomala bengalensis</i>	+	+
<i>Onthophagus catta</i>	+	+
<i>Onthophagus bonasus</i>	+	+
<i>Adoretus</i> sp.	+	+
<i>Ochodeus</i> sp.	+	+
<i>Peltonotus nasutus</i> Arrow	+	+
<i>Apogonia ferruginea</i>	+	+
Family: Coccinellidae		
<i>Coccinella septempunctata</i>	+	+
<i>Menochilus sexmaculatus</i>	+	+
Family: Curculionidae		
<i>Myllocerus</i> sp.	+	+
<i>Hypolixus truncatulus</i> Fab.	+	+
Family: Cicindelidae		
<i>Cicindella</i> sp.	+	+
Family: Elateridae		
<i>Melanotus</i> sp.	+	+
Family: Cerambycidae		
<i>Plocaederus</i> sp.	+	+
Family: Meloidae		
<i>Cylindrothorax pictus</i> Fab.	+	+
Order: Lepidoptera		
Family: Pieridae		
<i>Catopsila pomona</i> Cramer	+	-
<i>Colotis vestalis</i> Butler	+	-
<i>Colias fieldii</i> Menetries	+	-
<i>Eurema hecabe</i>	+	-
<i>Anaphaeis aurota</i>	+	-
Family: Lycaenidae		
<i>Lampides boeticus</i> Linn.	+	-
<i>Euchrysops cnejus</i>	+	-
Family: Danaidae		
<i>Danaus chrysippus</i>	+	-

Family: Papilionidae		
<i>Papilio demoleus</i> Linn.	+	-
Family: Nymphalidae		
<i>Junonia orithya</i> Linn	+	-
Family: Hesperidae		
<i>Hesperilla ornata</i> Leach	+	+
Family: Noctuidae		
<i>Earias insulana</i> Boisduval	+	+
<i>Mythimna separata</i>	+	+
<i>Agrotis ipsilon</i> Hufnagel	+	+
<i>Chrysodeixis chalcites</i> Esper	+	+
<i>Thysanoplusia orichalcae</i> Fab.	+	+
<i>Heliothis peltigera</i> Schiff	+	+
<i>Spodoptera exigua</i> Hubner	+	+
<i>Pericallia ricini</i> Fab.	+	+
Family: Crambidae		
<i>Leucinodes orbonalis</i> Guenee	+	+
<i>Hymenia recurvalis</i> Cramer	+	+
<i>Cnaphalocrocis medinalis</i>	+	+
<i>Cryptographis indica</i> Saunders	+	+
Family: Pyralidae		
<i>Sphenarches caffer</i> Zell	+	+
<i>Scirpophaga nivella</i>	+	+
<i>Etiella zinckenella</i> Treitschke	+	+
Family: Arctidae		
<i>Utethesia pulchella</i> Linn.	+	+
<i>Cretonotos gangis</i> Linn.	-	+
Family: Sphingidae		
<i>Acherontia styx</i>	+	-
Family: Geometridae		
<i>Tephрина</i> sp.	+	+
Unidentified species A	+	+
Unidentified species B	+	-
Order: Hemiptera		
Family: Pentatomidae		
<i>Nezara viridula</i>	+	+
<i>Bagrada hilaris</i>	+	+
<i>Aspongopus janus</i>	+	-
<i>Andrallus spinidens</i>	+	-
<i>Alcaeus</i> sp.	+	-
<i>Piezodorus</i> sp.	+	-
<i>Oncocephalus</i> sp.	+	-
Family: Pyrrhocoridae		
<i>Dysdercus cingulatus</i> Fab.	+	+
<i>Dysdercus koenigii</i>	+	+
Family: Lygaeidae		
<i>Aphanus</i> sp.	+	+
Family: Coreidae		
<i>Clavigrella</i> sp.	+	-
Family: Aphididae		
<i>Lipaphis erysimi</i>	+	+
<i>Myzus persicae</i>	+	-
Family: Fulgoroidae		
<i>Pyrilla perpusilla</i> Walker	+	+
Order: Hymenoptera		
Family: Apidae		
<i>Xylocopa fenestrata</i> Fab.	+	-
<i>Xylocopa violacea</i>	+	-
<i>Apis cerana</i> Fab.	+	-

<i>Apis mellifera</i> Linn.	+	-
<i>Apis dorsata</i> Fab.	+	-
<i>Apis florea</i>	+	+
<i>Amegila cingulata</i>	+	-
Family: Formicidae		
<i>Dolichoderus affinis</i>	+	-
<i>Formica</i> sp.	+	-
<i>Dorylus</i> sp.	-	+
Family: Vespidae		
<i>Polistes</i> sp.	+	-
<i>Delta campaniforme</i>	+	-
<i>Eumenes fraternus</i>	+	-
Family: Tenthredinidae		
<i>Athalia proxima</i>	+	-
Family: Sphecidae		
<i>Sceliphron brunneum</i>	+	-
Family: Chrysomidae		
<i>Chrysis dugesi</i>	+	-
Family: Ichneumonidae		
<i>Enicospilus</i> sp.	+	-
<i>Delta</i> sp.	+	-
Unidentified species A	+	-
Unidentified species B	+	-
Unidentified species C	+	-
Unidentified species D	+	-
Unidentified species E	+	+
Order: Diptera		
Family: Muscidae		
<i>Musca nibulo</i>	+	-
<i>Musca domestica</i>	+	-
Family: Bombyliidae		
<i>Anthrax</i> sp.	+	-
Family: Tabanidae		
<i>Tabanus</i> sp.	+	-
Family: Calliphoridae		
<i>Chrysomya megacephala</i> Fab.	+	-
<i>Chrysomya rufifacies</i>	+	-
Family: Asilidae		
<i>Stichopogon</i> sp.	+	-
Family: Culicidae		
<i>Culex quinquefasciatus</i> Say	+	+
Order: Dictyoptera		
Family: Mantidae		
<i>Mantis religiosa</i> Linn.	+	-
<i>Deiphobe incisa</i> Werner	+	+
Family: Blattidae		
<i>Periplaneta americana</i> Linn.	+	-
Order: Orthoptera		
Family: Acrididae		
<i>Chrotogonus</i> sp.	+	-
<i>Ochrilidia</i> sp.	+	-
<i>Schistocerca gregaria</i>	+	-
<i>Oxya chinensis</i>	+	-
<i>Acrida</i> sp.	+	-
Family: Tettigoniidae	+	-
<i>Eucenocephalus</i> sp.	+	-
Unidentified species A	+	-
Family: Gryllidae		
<i>Acheta domesticus</i>	+	+

<i>Gryllus assimilis</i>	+	-
Order: Odonata		
Family: Libellulidae		
<i>Pantala flavescens</i>	+	-
<i>Bradinopyga geminata</i>	+	-
Family: Coenagrionidae		
<i>Agriocnemis femina</i> Brauer	+	-
<i>Rhodischnura nursei</i> Morton	+	-
Unidentified species A	+	-
Order: Neuroptera		
Family: Chrysopidae		
<i>Chrysopa carnea</i>	+	+
Family: Myrmeleontidae		
<i>Myrmeleon</i> sp.	-	+
Family: Ascalaphidae		
<i>Ululodes quadrimaculatus</i>	-	+
Order: Embioptera		
Family: Oligotomidae		
<i>Oligotoma</i> sp.	+	+

Table 2: Total entomofauna (number) observed using cage net trap collections during the period of study

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Status
Order: Coleoptera																	
Family: Scarabaeidae																	
<i>Anomala bengalensis</i> *	50	34	46	49	31	34	23	21	21	31	30	38	66	31	41	44	D
<i>Onthophagus catta</i>	3	11	26	17	21	31	32	18	3	7	8	3	4	11	26	20	D
<i>Onthophagus bonasus</i>	5	11	14	17	44	39	20	5	2	4	5	5	4	9	13	16	D
<i>Adoretus</i> sp.	14	1	6	14	64	48	43	30	13	12	22	21	17	4	9	13	D
<i>Ochodeus</i> sp.	12	8	7	20	83	62	45	36	5	10	5	26	15	10	8	10	D
<i>Peltonotus nasutus</i> *	58	29	31	47	63	54	48	49	24	32	34	50	59	34	34	42	D
<i>Apogonia ferruginea</i> *	25	39	42	53	126	117	124	99	2	9	17	16	22	21	34	46	D
Family: Coccinellidae																	
<i>Coccinella septempunctata</i>	359	19	26	28	14	15	20	30	121	163	223	306	354	24	24	20	D
<i>Menochilus sexmaculatus</i>	141	5	30	-	11	8	14	9	59	78	74	111	117	18	-	-	D
Family: Curculionidae																	
<i>Myloccerus</i> sp.*	91	37	37	38	47	37	50	42	53	53	65	77	89	30	31	24	D
<i>Hypolixus truncatulus</i>	35	29	29	51	28	32	28	38	21	18	18	20	28	20	30	40	D
Family: Cicindelidae																	
<i>Cicindella</i> sp.*	68	23	30	31	119	101	79	61	40	52	59	55	66	20	24	30	D
Family: Elateridae																	
<i>Melanotus</i> sp.	-	-	-	-	13	12	5	12	-	-	-	-	-	-	-	-	F
Family: Cerambycidae																	
<i>Plocaederus</i> sp.	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	R
Family: Meloidae																	
<i>Cylindrothorax pictus</i>	4	15	27	67	50	71	76	50	-	1	3	7	5	17	18	16	D
Order: Lepidoptera																	
Family: Pieridae																	
<i>Catopsila pomona</i>	2	-	-	1	19	8	10	2	-	-	-	-	1	1	-	2	R
<i>Colotis vestalis</i>	39	3	-	1	56	47	52	17	20	21	38	33	39	3	3	2	D
<i>Colias fieldii</i>	22	11	7	8	37	29	26	12	-	7	14	18	24	12	6	7	D
<i>Eurema hecabe</i>	22	1	4	2	52	46	48	45	2	8	10	14	21	1	4	2	D
<i>Anaphaes aurota</i>	2	-	-	2	-	-	-	-	-	-	-	2	1	1	-	2	R
Family: Lycaenidae																	
<i>Lampides boeticus</i>	29	-	1	1	129	124	89	84	5	19	23	41	30	1	2	1	D
<i>Euchrysops cnejus</i>	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	R
Family: Danaidae																	
<i>Danaus chrysippus</i>	30	7	11	12	3	15	12	16	10	15	20	17	29	5	13	7	D
Family: Papilionidae																	
<i>Papilio demoleus</i>	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	R
Family: Nymphalidae																	
<i>Junonia orithya</i>	12	-	-	-	-	-	-	-	-	1	1	5	13	-	-	-	F
Family: Hesperidae																	
<i>Hesperilla ornata</i>	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	R
Family: Noctuidae																	
<i>Earias insulana</i>	42	13	24	21	22	25	18	11	18	28	33	29	43	13	24	17	D
<i>Mythimna separata</i>	43	7	8	10	51	54	41	46	21	25	36	43	43	6	7	8	D
<i>Agrotis ipsilon</i> *	76	9	17	17	55	52	35	30	62	57	64	62	71	10	15	14	D
<i>Chrysodeixis chalcites</i>	34	8	9	17	41	54	42	48	19	25	32	38	36	9	13	14	D
<i>Thysanoplusia orichalcea</i> *	157	33	42	58	88	90	81	80	76	90	104	117	163	33	40	45	D
<i>Heliothis peltigera</i> *	66	13	15	18	42	36	40	48	33	55	47	57	61	10	10	10	D
<i>Spodoptera exigua</i>	6	-	-	3	2	-	1	4	1	-	-	2	3	-	-	-	F
<i>Pericallia ricini</i>	1	-	1	-	-	-	-	-	-	-	-	-	2	1	1	-	R
Family: Crambidae																	
<i>Leucinodes orbonalis</i>	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	R
<i>Hymenia recurvalis</i> *	94	29	34	37	54	48	52	54	44	71	89	96	93	30	25	20	D
<i>Cnaphalocrocis medinalis</i>	4	9	12	8	3	2	6	10	-	-	1	1	3	5	6	9	F
<i>Cryptographis indica</i>	8	-	-	2	-	7	-	-	1	2	5	7	8	1	-	-	F
Family: Pyralidae																	
<i>Sphenarches caffer</i>	9	11	8	1	5	7	8	7	4	2	2	7	8	8	9	10	D
<i>Scirpophaga nivella</i>	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	5	R
<i>Etiella zinckenella</i>	35	2	8	4	15	10	9	17	12	12	22	18	30	5	8	4	D
Family: Arecidae																	

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Status
<i>Utethesia pulchella</i>	6	14	19	17	14	13	18	22	1	2	7	6	6	10	18	15	D
Family: Sphingidae																	
<i>Acherontia styx</i>	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	R
Family : Geometridae																	
<i>Tephрина sp.*</i>	194	17	27	32	95	94	97	132	92	124	146	173	198	19	30	36	D
Unidentified species A	2	-	-	-	-	1	-	-	1	2	3	3	1	-	-	-	R
Unidentified species B	2	1	-	-	-	3	-	-	-	-	-	-	1	-	-	-	R
Order:Hemiptera																	
Family:Pentatomidae																	
<i>Nezara viridula*</i>	126	10	18	25	22	23	23	31	45	82	81	93	120	10	20	20	D
<i>Bagrada hilaris</i>	85	-	-	3	16	18	24	20	23	56	76	76	85	-	-	-	D
<i>Aspongopus janus</i>	-	-	5	7	1	-	-	-	-	-	1	-	-	-	6	8	F
<i>Alcaeus sp.</i>	-	1	3	1	4	2	5	3	-	-	-	-	-	-	2	1	F
<i>Andrallus spinidens</i>	-	-	1	4	-	-	3	7	-	-	-	1	4	2	-	5	F
<i>Piezodorus sp.</i>	7	4	6	-	39	32	35	24	12	11	18	10	7	3	2	3	D
<i>Oncocephalus sp.</i>	-	-	-	-	3	4	-	6	-	-	-	1	1	2	-	-	F
Family:Pyrrhocoridae																	
<i>Dysdercus cingulatus</i>	40	1	16	23	6	8	4	4	-	15	22	40	39	4	17	10	D
<i>Dysdercus koenigii</i>	-	3	5	1	-	1	-	-	-	-	2	1	1	2	5	4	F
Family:Lygaeidae																	
<i>Aphanus sp.</i>	4	-	-	-	-	-	-	5	1	-	-	3	4	-	-	-	F
Family : Coreidae																	
<i>Clavigrella sp.</i>	1	-	2	-	4	3	9	9	-	-	2	2	2	-	-	-	F
Family:Aphididae																	
<i>Lipaphis erysimi</i>	50	-	-	-	-	-	-	-	-	13	24	29	51	-	-	-	D
<i>Myzus persicae</i>	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	R
Family:Fulgoridae																	
<i>Pyrilla perpusilla</i>	-	1	1	1	1	2	-	-	-	-	-	-	-	-	-	-	R
Order:Hymenoptera																	
Family:Apidae																	
<i>Xylocopa fenestrata</i>	17	13	10	5	7	4	8	12	8	12	19	22	21	15	15	10	D
<i>X. violacea</i>	-	4	11	32	55	59	75	65	1	1	2	2	4	5	9	20	D
<i>Apis cerana</i>	131	-	-	3	11	15	29	30	63	97	111	112	127	-	-	-	D
<i>Apis mellifera</i>	198	4	14	18	31	45	50	66	85	117	134	148	192	8	8	10	D
<i>Apis dorsata</i>	21	-	-	1	5	12	13	27	10	13	20	21	25	-	-	-	D
<i>Apis florea</i>	98	16	28	43	28	22	32	61	45	54	66	92	103	23	33	34	D
<i>Amegila cingulata</i>	2	-	-	-	-	-	-	-	-	2	8	9	5	-	-	-	F
Family:Formicidae																	
<i>Dolichoderus affinis</i>	57	13	11	15	19	22	20	26	13	19	25	34	58	9	6	8	D
<i>Formica sp.</i>	50	11	9	24	23	27	34	24	21	24	31	39	48	10	11	10	D
Family: Vespidae																	
<i>Polistes sp.</i>	-	2	3	-	-	-	-	-	3	5	-	-	-	3	4	-	F
<i>Delta campaniforme</i>	1	-	-	-	-	-	-	-	-	-	2	4	-	-	-	-	R
<i>Delta sp.</i>	-	3	3	-	-	-	3	-	-	-	6	5	-	1	4	3	F
<i>Eumenes fraternus sp.</i>	-	-	1	3	1	3	2	-	-	-	-	-	-	1	-	1	R
Family:Tenthredinidae																	
<i>Athalia proxima</i>	5	-	-	-	-	-	-	-	-	-	1	2	3	-	-	-	R
Family:Sphecidae																	
<i>Sceliphron brunneum</i>	10	12	16	10	2	4	4	1	1	3	16	16	10	15	18	11	D
Family:Chrysomidae																	
<i>Chrysis dugesi</i>	3	1	-	-	-	-	-	-	-	-	-	-	3	-	-	-	R
Family:Ichneumonidae																	
<i>Enicospilus sp.</i>	37	-	-	-	3	4	-	-	16	29	35	57	33	30	-	-	D
Unidentified species A	-	5	7	3	-	-	-	-	-	-	-	-	-	-	-	-	R
Unidentified species B	2	-	-	-	-	-	1	1	-	-	1	3	4	2	6	4	F
Unidentified species C	-	3	5	2	14	10	6	5	-	2	1	1	2	-	-	-	F
Unidentified species D	-	-	1	1	2	-	-	-	1	2	4	4	10	-	-	-	F
Unidentified species E	-	2	6	5	-	-	-	-	1	2	2	-	-	-	-	-	F
Order:Diptera																	
Family:Muscidae																	
<i>Musca nubo</i>	3	-	1	7	3	2	1	2	11	12	16	6	3	-	-	3	F
<i>Musca domestica</i>	217	9	15	19	84	83	86	79	116	110	120	173	217	9	13	21	D
Family:Bombyliidae																	
<i>Anthrax sp.</i>	4	-	1	-	-	-	-	-	-	2	1	6	2	-	1	5	F

Contd...

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Status
Family :Tabanidae																	
<i>Tabanus</i> sp.	1	1	-	-	-	-	-	-	-	-	-	1	2	2	-	-	R
Family:Calliphoridae																	
<i>Chrysomya megacephala</i>	23	-	-	-	-	-	-	-	11	6	14	15	23	-	-	-	F
<i>Chrysomya rufifacies</i>	10	-	1	-	-	-	-	-	6	2	7	2	10	-	-	-	F
Family:Asilidae																	
<i>Stichopogon</i> sp.	5	11	12	13	15	20	25	30	1	-	4	6	8	16	18	20	D
Family:Culicidae																	
<i>Culex quinquefasciatus</i>	208	20	23	62	102	114	115	98	136	134	164	182	203	19	24	35	D
Order:Dictyoptera																	
Family:Mantidae																	
<i>Mantis religiosa</i>	-	-	-	-	-	-	-	-	-	-	2	-	1	-	-	-	R
<i>Deiphobe incisa</i>	-	-	-	-	-	-	2	-	-	-	-	2	-	-	-	-	R
Family:Blattidae																	
<i>Periplaneta americana</i>	-	-	2	-	-	-	-	-	2	-	-	-	-	-	-	-	R
Order:Orthoptera																	
Family:Acrididae																	
<i>Chrotogonus</i> sp.*	175	27	25	54	87	100	89	79	101	121	140	148	179	26	27	45	D
<i>Ochrilidia</i> sp.*	168	4	10	39	22	21	14	20	51	91	99	123	160	1	5	20	D
<i>Schistocerca gregaria</i>	1	-	-	-	2	3	4	-	1	3	3	3	1	1	1	-	F
<i>Oxya chinensis</i>	33	10	10	9	39	50	58	69	2	4	3	6	33	5	5	10	D
<i>Acrida</i> sp.	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	R
Family:Tettigoniidae																	
<i>Eucenocephalus</i> sp.	4	5	4	6	-	4	7	8	-	5	6	9	5	4	5	6	F
Unidentified species A	3	1	-	-	-	-	5	5	-	-	-	-	-	1	-	-	R
Family:Gryllidae																	
<i>Acheta domesticus</i>	10	17	11	27	33	41	37	42	8	10	11	8	10	24	19	29	D
<i>Gryllus assimilis</i>	12	-	6	8	26	31	35	28	-	2	8	14	13	2	3	6	D
Order:Odonata																	
Family:Libellulidae																	
<i>Pantala flavescens</i>	2	-	-	-	-	-	11	4	4	4	3	2	2	-	-	-	F
<i>Bradinopyga geminata</i>	-	5	8	15	3	4	8	10	4	2	6	8	-	6	8	15	F
Family :Coenagrionidae	1	-	-	-	-	-	-	-	-	-	1	2	2	-	-	-	R
<i>Agriocnemis femina</i>	8	-	1	-	8	6	5	4	1	10	11	7	10	5	4	-	F
<i>Rhodischnura nursei</i>	-	-	1	1	-	-	2	2	-	-	1	1	-	-	-	-	R
Unidentified species A	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R
Order:Neuroptera																	
Family:Chrysopidae																	
<i>Chrysopa carnea</i>	193	10	8	20	22	16	16	15	93	103	122	160	194	13	10	18	D
Order:Embioptera																	
Family:Oligotomidae																	
<i>Oligotoma</i> sp.	8	-	-	-	-	-	-	-	-	2	4	7	9	-	-	-	F

D-Dominant , F-Frequent , R-Rare

D>100 100>F>16 R□16

* insects attaining pest status

Table 3: Total entomofauna (number) observed in light trap collection during the period of study

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Status
Order: Coleoptera																	
Family: Scarabaeidae																	
<i>Anomala bengalensis</i>	6	10	30	45	20	19	10	1	-	-	-	-	6	9	31	52	D
<i>Onthophagus catta</i>	25	27	28	22	26	19	11	10	-	-	-	-	24	28	27	21	D
<i>Onthophagus bonasus</i>	5	4	5	3	2	1	2	-	-	-	-	-	4	4	5	2	F
<i>Adoretus</i> sp.	6	4	3	2	-	-	-	-	-	-	-	-	4	5	3	2	F
<i>Ochodeus</i> sp.	10	10	15	35	40	36	30	20	-	-	-	-	8	9	15	30	D
<i>Peltonotus nasutus</i>	11	-	-	-	7	9	11	6	-	-	-	1	8	7	6	15	F
<i>Apogonia ferruginea</i>	10	15	17	18	16	15	10	2	1	1	-	-	3	17	16	20	D
Family: Coccinellidae																	
<i>Coccinella septempunctata</i>	-	-	-	-	-	-	-	-	2	2	-	3	-	-	-	9	F
<i>Menochilus sexmaculatus</i>	-	10	-	-	-	-	-	-	-	-	-	-	24	5	-	-	F
Family: Curculionidae																	
<i>Mylocerus</i> sp.	15	16	30	8	-	-	-	-	7	15	14	12	13	7	31	21	D
<i>Hypolixus truncatulus</i>	9	10	11	13	15	17	16	15	-	-	-	-	9	9	8	25	D

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Status
Family: Cicindellidae																	
<i>Cicindella</i> sp.	-	4	6	7	7	-	-	-	-	-	-	-	-	-	11	10	F
Family: Elateridae																	
<i>Melanotus</i> sp.	-	-	-	-	-	-	-	-	-	-	-	5	5	3	1	-	R
Family: Cerambycidae																	
<i>Plocaederus</i> sp.	-	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-	R
Family: Meloidae																	
<i>Cylindrothorax pictus</i>	4	5	6	5	1	2	1	-	-	-	-	-	3	5	3	11	F
Order: Lepidoptera																	
Family: Noctuidae																	
<i>Earias insulana</i>	5	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R
<i>Mythimna separata</i>	-	5	5	-	4	3	7	1	-	-	-	-	-	-	4	3	F
<i>Agrotis ipsilon</i>	45	35	20	10	7	-	-	-	-	-	-	-	40	35	20	12	D
<i>Chrysodeixis chalcites</i>	-	5	7	10	-	-	-	-	-	-	-	-	-	-	-	10	F
<i>Thysanoplusia orichalcea</i>	5	3	4	-	-	-	-	-	-	-	-	-	4	3	4	-	F
<i>Heliothis peltigera</i>	1	1	1	1	-	-	-	-	5	10	3	-	1	-	1	8	F
<i>Spodoptera exigua</i>	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	3	R
<i>Pericallia ricini</i>	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	R
Family: Crambidae																	
<i>Leucinodes orbonalis</i>	-	1	-	-	4	-	-	-	-	-	-	-	-	-	-	-	R
<i>Hymenia recurvalis</i>	5	3	8	10	14	3	2	4	-	-	-	-	-	1	8	30	F
<i>Cnaphalocrocis medinalis</i>	-	5	-	5	2	1	-	2	-	-	-	-	-	5	5	4	F
<i>Cryptographis indica</i>	5	5	5	-	-	-	-	-	-	-	-	-	-	5	5	3	F
Family: Hesperidae																	
<i>Hesperilla ornata</i>	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R
Family: Pyralidae																	
<i>Sphenarches caffer</i>	-	3	6	6	7	4	4	2	-	-	-	-	3	6	-	-	F
<i>Scirpophaga nivella</i>	10	15	10	10	5	-	-	-	-	-	-	-	11	14	9	5	F
<i>Etiella zinckenella</i>	-	5	3	7	-	-	-	-	-	-	-	-	-	3	5	6	F
Family: Arctidae																	
<i>Utethesia pulchella</i>	12	23	11	16	18	10	5	-	-	-	-	-	10	23	11	15	D
<i>Cretonotos gangis</i>	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R
Family : Geometridae																	
<i>Tephрина</i> sp.	10	7	5	5	3	-	-	-	10	10	11	12	10	7	5	-	F
Unidentified species A	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	R
Order: Hemiptera																	
Family: Pentatomidae																	
<i>Nezara viridula</i>	-	-	-	5	10	20	15	10	-	-	-	-	-	-	-	10	F
<i>Bagrada hilaris</i>	1	1	1	3	5	6	5	-	-	-	-	-	-	1	1	2	F
Family: Pyrrhocoridae																	
<i>Dysdercus cingulatus</i>	-	-	-	-	-	-	-	-	2	-	4	-	5	6	-	9	F
<i>Dysdercus koenigii</i>	-	-	-	-	-	-	-	-	7	5	4	-	2	3	2	1	F
Family: Lygaeidae																	
<i>Aphanus</i> sp.	-	-	-	-	-	-	-	-	-	-	4	6	5	10	7	6	F
Family: Aphididae																	
<i>Lipaphis erysimi</i>	10	-	-	-	-	-	-	-	-	-	-	7	9	-	-	-	F
Family: Fulgoridae																	
<i>Pyrilla perpusilla</i>	5	4	1	-	1	-	-	-	-	-	-	-	6	3	4	2	F
Order: Hymenoptera																	
Family: Apidae																	
<i>Apis florea</i>	4	1	12	3	-	-	-	-	10	10	10	8	4	1	12	-	F
Family: Formicidae																	
<i>Dorylus</i> sp.	40	40	43	35	37	33	20	-	-	-	-	-	-	35	40	41	D
Unidentified sp. C	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2	R
Order: Diptera																	
Family: Muscidae																	
<i>Musca nubo</i>	-	4	3	-	-	-	-	-	1	5	3	1	-	4	3	-	F
<i>Musca domestica</i>	10	5	10	-	-	-	-	-	-	-	-	-	9	4	10	-	F
Family: Culicidae																	
<i>Culex quinquefasciatus</i>	10	5	7	17	20	19	10	10	8	10	-	5	10	5	7	35	D
Order: Dictyoptera																	
Family: Mantidae																	
<i>Deiphobe incisa</i>	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Status
Order: Orthoptera																	
Family: Gryllidae																	
<i>Acheta domesticus</i>	10	12	10	1	1	-	-	-	-	-	2	-	10	12	11	1	F
Order: Neuroptera																	
Family: Chrysopidae																	
<i>Chrysopa carnea</i>	-	5	-	5	2	1	-	-	-	-	-	-	-	4	-	-	F
Family: Myrmeleontidae																	
<i>Myrmeleon</i> sp.	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	R
<i>Urolodes quadrimaculatus</i>	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	R
Order: Embloptera																	
Family: Oligotomidae																	
<i>Oligotoma</i> sp.	-	-	3	4	1	-	-	-	-	-	-	-	1	4	4	5	F

D-Dominant, F-Frequent, R-Rare
D>100 100>F>16 R□16