

**STUDIES ON THE BIODIVERSITY OF INSECT FAUNA
AT AGRO-FORESTRY ECOSYSTEM OF IGKV,
RAIPUR (CHHATTISGARH)**

M.Sc. (Ag.) Thesis

by

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**DEPARTMENT OF ENTOMOLOGY
COLLEGE OF AGRICULTURE
INDIRA GANDHI KRISHI VISHWAVIDYALAYA
RAIPUR (Chhattisgarh)**

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Thesis

Submitted to the

Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.)

by

Hemkant Chandravanshi

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CERTIFICATE – I

This is to certify that the thesis entitled “**Studies on the biodiversity of insect fauna at agro-forestry ecosystem of IGKV, Raipur (Chhattisgarh)**” submitted in partial fulfilment of the requirements for the degree of **Master of Science in Agriculture** of the Indira Gandhi Krishi Vishwavidyalaya, Raipur, is a record of the bonafide research work carried out by **Hemkant Chandravanshi** under my guidance and supervision. The subject of the thesis has been approved by Student's Advisory Committee and the Director of Instructions.

No part of the thesis has been submitted for any other degree or diploma or has been published/published part has been fully acknowledged. All the assistance and help received during the course of the investigations have been duly acknowledged by him.

Date: 20th July, 2015



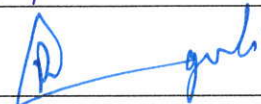
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CERTIFICATE – II

This is to certify that the thesis entitled “**Studies on the biodiversity of insect fauna at agro-forestry ecosystem of IGKV, Raipur (Chhattisgarh)**” submitted by **Hemkant Chandravanshi** to the Indira Gandhi Krishi Vishwavidyalaya, Raipur in partial fulfilment of the requirements for the degree of **Master of Science in Agriculture** in the Department of **Entomology** has been approved by the external examiner and Student's Advisory Committee after oral examination.

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Hemkant Chandravanshi

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LIST OF SYMBOLS /NOTATIONS

%	Percentage
°C	Degree celcius
cm	Centimeter
H	Shannon-Weaver diversity index
km	Kilometer
mm	Millimeter
W	Watt

LIST OF ABBREVIATION

CD	Critical difference
CG	Chhattisgarh
CV	Coefficient of variance
FN	Fort night
IGKV	Indira Gandhi Krishi Vishwavidyalaya
MSL	Mean sea level
NPKCa	Nitrogen, Phosphorus, Potassium, Calcium
RBD	Randomised block design
SEm	Standard error due to mean
SMW	Standard meteorological weeks
Sp	Species
USA	United States of America

THESIS ABSTRACT

- (a) Title of the Thesis : Studies on the biodiversity of insect fauna at agro-forestry ecosystem of IGKV, Raipur (Chhattisgarh).
- (b) Full Name of the Student : Hemkant Chandravanshi
- (c) Major Subject : Entomology
- (d) Name and Address of the Major Advisor : Dr. (Smt.) Jayalaxmi Ganguli
Assistant Professor, Department of Entomology,
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- (e) Degree to be Awarded : M.Sc. (Ag.) Entomology

Signature of the Student

Signature of Major Advisor

Date: 20/07/15

Signature of Head of the Department

ABSTRACT

The present investigation entitled “Studies on the biodiversity of insect fauna at agro-forestry ecosystem of IGKV, Raipur (Chhattisgarh)” was conducted during October 2014 to April 2015. Biodiversity is instrumentally important not only for the production of food, but for other ecological services as well, including the recycling of nutrients, regulation of microclimate and local hydrological processes, suppression of undesirable organisms and detoxification of noxious chemicals which included studies. The collection, identification and classification of various insect fauna collected during the present studies under agro-forestry ecosystem of IGKV clearly indicates that maximum domination of lepidoptera was observed in collections made by sweep net followed by diptera and hemiptera and in the light trap collections hemiptera was the dominating order followed by diptera and Lepidoptera, while in case of collection by pit fall trap method, the maximum dominating order was hymenoptera followed by diptera. In case of Berlese funnel, maximum collection belonged to order hymenoptera followed by acarina.

Maximum number of insects were collected in pit fall trap (1045) followed by sweep net (443), Berlese funnel (330) and light trap (213). Among the pit fall trap collections, the maximum number of insects belonged to order hymenoptera (639) with domination of family formicidae. This indicates that crawling insects dominated the fauna of agro-forestry. Order diptera significantly dominated towards yellow pan among the various coloured pans/basins used in the pit fall trap.

Studies on the seasonal incidence of major insect pest of karanja, *Pongamia pinnata* revealed four insect pests, namely the leaf blotch miner, plant sucking bug, hairy caterpillar, *Euproctis* sp. and leaf hopper. Maximum activity of leaf blotch miner and plant sucking bug was noticed during 1st FN of December, while peak incidence of hairy caterpillar, *Euproctis* sp. was noticed during the 2nd FN of December, while a poor population of leaf hopper with its highest activity was observed during the 1st FN of January.

सारांश

“इंदिरा गांधी कृषि विश्वविद्यालय के कृषि वानिकी पारिस्थितिक तंत्र में कीटों की जैव विविधता का अध्ययन” नामक जांच शीर्षक इंदिरा गांधी कृषि विश्वविद्यालय के कृषि वानिकी प्रक्षेत्र में अक्टुबर 2014 से अप्रैल 2015 के मध्य संचालित किया गया। जैव विविधता न केवल भोजन के उत्पादन के लिए, बल्कि अन्य पारिस्थितिकी सेवाओं के लिए भी महत्वपूर्ण है। जिसमें सूक्ष्म जलवायु का नियंत्रण, पोषक तत्वों का पुनः उपयोग, स्थानीय जलवायु, जल वैज्ञानिक प्रक्रियाएं, हानि कारक जीवों का नियमन और अत्यन्त जहरीले रासायनो का निर्विषिकरण आदि भी सम्मिलित है। इंदिरा गांधी कृषि विश्वविद्यालय के कृषि वानिकी पारिस्थितिकी तंत्र में वर्तमान अध्ययन विभिन्न प्रकार की विधियों द्वारा किया गया। जिसमें विभिन्न कीटों का संग्रहण, पहचान और उसका वर्गीकरण किया गया, इसके अंतर्गत हस्तजाल द्वारा संग्रहण में लेपिडोप्टेरा गण के कीटों की संख्या अधिक थी, उसके बाद डिप्टेरा और हेमिप्टेरा गण के कीटों की संख्या अधिकतम थी। परन्तु प्रकाश प्रपंच के संग्रहण में हेमिप्टेरा गण उसके पश्चात डिप्टेरा और लेपिडोप्टेरा गण के कीटों की संख्या अधिक थी। जबकि पिट फाल प्रपंच विधि में हायमेनोप्टेरा गण के कीटों की संख्या अधिक मिला तत्पश्चात् डिप्टेरा गण के कीटों की संख्या अधिक मिला। बर्लिस फनल विधि में अत्यधिक संग्रहण हायमेनोप्टेरा गण के कीटों की पाई गई उसके बाद अष्टपदी (एकेरिना)। सबसे अधिक संख्या में कीटों का संग्रहण पिट फाल विधि द्वारा किया गया (1045), उसके बाद हस्तजाल (443), बर्लिस फनल (330) एवं प्रकाश प्रपंच में (213) मिला। पिट फाल संग्रहण विधि में हायमेनोप्टेरा गण (639) के फार्मिसिडी परिवार के

कीटों की संख्या अधिक थी, जो कि यह सूचित करता है कि उक्त पारिस्थितिक तंत्र में रेंगने वालों कीटों की संख्या अधिक थी।

करन्ज, *पोंगामिया पिन्नाटा* के प्रमुख कीटों की मौसमी घटनाओं पर अध्ययन किया गया, जिसमें चार प्रमुख कीटों जैसे कि पर्ण ब्लाच सुरंगक, पौध चुषक मत्कुण, रोयेंदार इल्ली और पर्ण फुदका का पता चला। दिसम्बर के प्रथम पखवाड़े के दौरान पर्ण ब्लाच सुरंगक और पौध चुषक मत्कुण की अधिकतम गतिविधि देखी गई। जबकि दिसम्बर के दूसरे पखवाड़े में रोयेंदार इल्ली का वर्चस्व था तथा जनवरी माह के प्रथम पखवाड़े में पर्ण फुदका की संख्या कम परन्तु उसकी गतिविधि उच्चतम पाई गई।

CHAPTER - I

INTRODUCTION

In agricultural ecosystems, biodiversity is instrumentally important not only for the production of food, but for other ecological services as well, including the recycling of nutrients, regulation of microclimate and local hydrological processes, suppression of undesirable organisms and detoxification of noxious chemicals.

One of the most important problems faced by the developing countries is producing food in adequate quantities and of good quality for the fast growing population. It is also necessary to ensure that the quality of land resources that are directly or indirectly utilized in producing food is maintained and improved. Therefore, it is important to increase productivity and at the same time to conserve and enhance the quality of eco-system.

Biological diversity means the variability among the living organisms from all sources including terrestrial, marine, and other aquatic ecosystems (Harper and Hawksworth, 1994). This includes diversity within species, between species, and of ecosystems. Biological diversity refers to the entire body of organisms, their ecological complexity within the environment, and all the ecological processes in relation to these systems (Primack, 1993 and Liu, 1999). Approximately 30 million species are found worldwide, of which about 1.4 million have been briefly described; of these, about 750,000 are insects. Insects now comprise >75% of all described animal species and exhibit not only a rich variety of form, color, and shape, but also a range of ecological adaptations unexcelled by any other group (Cheng, 1976).

There have been some reports on the impacts of forest plantations on the diversity and abundance of insects but most of these studies have been conducted in Africa (e.g. Nummelin and Hanski, 1989, Nummelin and Borrowiec, 1991, Nummelin and Fursch, 1992, Eggleton *et al.*, 1995, Eggleton *et al.*, 1996) with

only a few recent studies being done in Asia (Holloway *et al.*, 1992, Hill *et al.*, 1995, Chey *et al.*, 1997, Hamer *et al.*, 1997 and Intachat *et al.*, 1997).

Agro-forestry is a land management and farming system which is not only capable of producing food from marginal agricultural land but also capable of maintaining and improving the quality of environment. The integration of farming with forestry practices on the farm for the benefit of agriculture is known as agro-forestry. Agro-forestry has a tremendous scope in India as it has achieved self-sufficiency in food production, and its attention is becoming more focused on the ecological problems and shortage of fuel, fodder, forest produce and other outputs as well as unemployment.

Agroforestry is an activity that combines production on the same plot of land; from annual agricultural activities such as crops and pasture and from delayed long-term production by trees for example timber and services. This is obtained either by planting trees on agricultural land or by cropping on forested land. Plots that combine arable intercrops with forestry trees.

The forest cover of India is 6,92,027 km² which is 19.30% of total geographical area and Chhattisgarh has a vast forest canopy of about 41.18 percent of its 135191 Km² total geographical area. (India State of Forest Report, 2011)

Over one million species of insects have been described, but current estimates of total insect diversity vary from 5-80 million species of insects. Beetles (Coleoptera) make up 40% of described insect species, but some entomologists suggest that flies (Diptera) and Hymenoptera (wasps, bees and ants) could be as diverse or more so. Five orders of insects stand out in their levels of species richness: Hymenoptera, Diptera, Coleoptera, Lepidoptera, and the Hemiptera (www.google.com).

The present studies on biodiversity of insect fauna at Agro-forestry ecosystem of IGKV, Raipur included collection, identification and classification of various insect fauna under agro-forestry ecosystem by pit fall trap, sweep net collection, Berlese funnel method and light trap. Various plant species present in the

above mentioned agro-forestry ecosystem included Karanja, *Pongamia pinnata* L. Pierre, Mangium, *Acacia mangium*, Aonla, *Emblica officinalis*, Meetha neem, *Murraya koenigii*, Jatropha, *Jatropha curcas*, Sheesham, *Dalbergia sissoo*, White siris, *Albizia procera*, Drumstick, *Moringa oleifera*, Mahua, *Madhuca indica*, Char, *Buchnamia lanzan*, Bamboo, *Bambusa sp.*, Eucalyptus, *Eucalyptus sp.*, Teak, *Tectona grandis* and Sandal, *Santalum album*. A multitier agroforestry system in the field of agro-forestry included Turmeric, *Curcuma longa* as the herbal layer Aonla, *Emblica officinalis* forming a layer with meetha neem, *Murraya koenigii* as the middle layer and Mangium, *Acacia mangium* forming the top most layer.

In order to study the seasonal incidence of major insect pests, one of the component tree species, Karanja was selected for the present studies. Karanja, *Pongamia pinnata* L. Pierre (Family-Leguminosae) is a medium sized glabrous tree. It grows easily from seed. Historically, this plant has long been used as a source of traditional medicines, animal fodder, green manure, timber, fish poison, fuel and also used as source of biodiesel. *P. pinnata* has an added advantage of nitrogen fixing ability and drought resistance due to its nodulation properties. (Sangwan *et al.* 2010).

Thus, to collect detailed information regarding the biodiversity of various insect population comprising the agro-forestry ecosystem system and to determine the seasonal incidence of major insect pest of karanja, *P. pinnata* L. Pierre, the present investigation entitled “**Studies on the biodiversity of insect fauna at agro-forestry ecosystem of IGKV, Raipur (Chhattisgarh)**”, was framed.

The specific objectives of the present study are

- Collection, identification and classification of various insect fauna under agro-forestry ecosystem of IGKV, Raipur (Chhattisgarh).
- To determine the seasonal incidence of major insect pests of karanja, *Pongamia pinnata*.

CHAPTER – II

REVIEW OF LITERATURE

The literature pertaining to the present investigation entitled “Studies on the biodiversity of insect fauna at agro-forestry ecosystem of IGKV, Raipur (Chhattisgarh)” were collected and grouped under the following headings:

- 2.1 Review of literature on agro-forestry system.
- 2.2 Review of literature on bio-diversity of insect pests.
- 2.3 Review of literature on sweep net collection.
- 2.4 Review of literature on pit fall trap.
- 2.5 Review of literature on light trap.
- 2.6 Review of literature on Berlese funnel.
- 2.7 Review of literature on pests of Karanja, *Pongamia pinnata*.

2.1 Review of literature on agro-forestry system

Leakey (1996) described that Agro-forestry is a dynamic ecologically based natural resource management system that, through the integration of trees/woody perennials in farm and rangelands, diversifies and sustains production for increased social, economic and environmental benefits.

The examples proving intercropped areas cause less harm by insects, disease, weeds, and erosion are numerous. In the Netherlands, intercropped cabbage and spurry showed a drastic reduction in defoliating caterpillars as compared to traditional mono cropping. In Canada, intercropping of onion, garlic, leeks, and chives with carrots has been shown to reduce common pests to the carrot crops (Innis, 1997).

Islam *et al.* (2006) from Bangladesh during July-December 2003 evaluated the pests associated with tree-rice agro-forestry systems. The tree species included *Acacia auriculiformis* (Akashmoni), *Casuarina equisetifolia* (Jhau) and *Acacia albida* (Albida). Albida and Jhau showed large canopies and light penetration was

high. Infestation was lowest in Albida-rice system, followed by Jhau-rice. Maximum infestation was in control plots (no trees). Trees with sparse canopy allowing easy penetration of light is suitable for tree-rice systems.

Ahmad (2009) described Agro-forestry as a land management and farming system that are not only capable of producing food from marginal agricultural land but also capable of maintaining and improving the quality of environment. The integration of farming with forestry practices on the farm for the benefit of agriculture is known as agro-forestry. Agro-forestry plays a vital role in achieving integrated rural and urban development.

Harinkhere *et al.* (2013) reported that among the insect pests, Teak skeletoniser, *Eutectona machaeralis*, as the most serious pest of Teak as per 39.3% respondents followed by Bamboo lesser leaf roller, *Pyrausta bambucivora* on bamboo (39.2%) and Mealy bug, *Ferrisia virgata* on Aonla with 37.5% respondents in Chhattisgarh. Termites were reported as major pests on Eucalyptus by 24.9% respondents in which two species were identified as, *Odentotermes horni* (Wasman) and *O. obesus* (Rambur). Gundhi bug, *Leptocorisa acuta* on Teak, (23.2%), Sal borer, *Hoplocerambyx spinicornis* (Newm) on sal (21.0%). Gundhi bug, *Leptocorisa acuta* on Karanj (15.4%) and Blue bug, *Chysocoris purpureus* on Jatropha (12.2%) were the other major damaging insect pests as reported by maximum numbers of farmers in the twelve districts of Chhattisgarh plains.

2.2 Review of literature on bio-diversity of insect pests

Belder and Den, (2000) reported on the relationships between plant protection and biodiversity, based on studies carried out during 1997-98 on leek-producing farms in 4 areas in the provinces of Limburg and Noord-Brabant, that the presence of *Thrips* (adults and nymphs) and their symptoms of *Thrips* damage were noticed during July-October.

Chandra *et al.* (2007) presented checklist of Orthoptera of Madhya Pradesh and Chhattisgarh, mentioning 139 species of Orthoptera belonging to 12 families. Of these, 94 species were reported from Madhya Pradesh and 84 species from Chhattisgarh. Ten species i.e. *Mecopoda elongate* (Linnaeus), *Xiphidiopsis citrine*

Redtenbacher, *Platygyllus lineaticeps* (Walker), *Ceracris* sp., *Clonacris kirbyi* (Finot), *Hieroglyphus concolor* (Walker), *Tridactylus Fasciatus* Guerin and *Xya opaca* (Walker) were recorded for the first time from these states.

Subharani *et al.* (2007) conducted systematic survey of hymenopteran parasitoids on certain insect pests of crops in different localities of Manipur varying in altitudes and seasons during 2003-2005 which revealed the occurrence of 36 (thirty six) species of parasitoids belonging to the families Aphididae, Chalcidae, Ichneumonidae and Braconidae. Of these, the family Aphididae included the maximum number of the parasitoid species. Among the parasitoids recorded 15 were polyphagous, 02 were oligophagous and 19 were species specific. Their period of occurrence varied depending upon the availability of the host insects as well as the host plants. From the study it also revealed that the maximum species abundance exist between 601-1200 m MSL.

Thakur *et al.* (2008) reported biodiversity of the lepidopterous pests in different locations of Varanasi, Uttar Pradesh, India, through periodical surveys and collection of the insects during 2006-07. In total, 21 species belonging to 11 families (Plutellidae, Pyralidae, Pyraustidae, Danaidae, Nymphalidae, Lycaenidae, Pieridae, Papilionidae, Hesperidae, Sphingidae, Noctuidae) were recorded from different locations of Varanasi. These lepidopterous insects were processed for their taxonomic and pest status. The highest number of species, which caused maximum economic damage to the crops were from family Noctuidae, followed by Pyralidae. In Noctuidae family, the larval stage was considered as the most damaging, as they cut the leaves and shoots and defoliated the whole plants. Noctuids were polyphagous in nature, with a wide range of host plants, i.e. gram (chickpea), tobacco, potato, tomato, cabbage, okra, cotton, etc. For pyralids, younger seedlings were most susceptible and their larvae bored into the fruits. The fruit showed clear holes made by larvae, which became unfit for consumption. The Pyralidae family preferred vegetable crops like cabbage, cauliflower, brinjal and various leguminous crops such as peas, beans, arhar (pigeon pea) etc. Rice crop was preferred by various insect of families, i.e. Pyraustidae, Nymphalidae and Hesperidae. Important species found during the study in locality were *Plutella xylostella*, *Cnaphalocrocis*

medinalis, *Pieris brassicae*, *Papilio demoleus*, *Spodoptera litura*, *Agrotis ypsilon* and *A. flammatrix* (*Ochropleura flammatrix*).

Bhagat (2011) reported about aphid pests, damaging forest trees in diverse areas and localities in Jammu Kashmir and Ladakh region of north-west Himalaya. Updated information pertaining to systematic checklist, host-range and species richness of 51 aphid species, under 26 genera, belonging to 10 different sub-families of family Aphididae, damaging 34 forest-tree species, distributed over 17 genera of 10 families, have been provided. Salix and poplars (Salicaceae), are found infested with highest number of aphid species as 23. The dominant aphid species attacking forest trees in different areas pertained to the sub-family Erisomatinae as 15 and aphid genera *viz.* *Chaitophorus* and *Pemphigus* incorporated highest number of species as 6 each. A catalogue on host-tree (forest) complex of aphids of Jammu, Kashmir and Ladakh region, has been presented.

Hui *et al.* (2011) studied on *Metarhizium anisopliae* to control locust plagues is a sustainable low-cost biological control measure with no pollution effects on society, and has an important significance in the protection of grassland ecosystem biodiversity. Through investigation on of insect community composition and structural diversity in different grassland locust control areas in Xilinguolemeng of Inner Mongolia, the influence on biodiversity was exposed. Major dominant pests and potential secondary pests were analyzed, which provides a basis for reference for establishing a grassland locust integrated control system.

Montagna *et al.* (2012) worked on structure of insect communities and insect biodiversity conservation in the Alpine wetland of Pian Gembro (Italy). Pitfall traps, sweep and collections of visually observed insects yielded 997 individuals representing 141 species from 11 insect families. The rank-frequency curve for bog insects was relatively steep indicating a low evenness due to the high abundance of low ranking species. The curve for insects collected in the surroundings was less steep pointing to a relatively high evenness due to a lower abundance of low ranking species. In both the bog and the surroundings the Shannon diversity index was generally highest at intermediate levels of disturbance. These results indicate that the DIMR strategies implemented for plant

biodiversity conservation is also appropriate to conserve insect species biodiversity.

2.3 Review of literature on sweep net collection

Dobbs *et al.* (2004) reported that the establishment of Paragonata, *Paragonatas divergens* for the first time in Florida, USA. A female was captured on May 16, 2003, by general sweep-net collection in Lee County, southwestern Florida, USA.

Khan and Ramamurthy (2004) correlated studied between light trap and sweep net collection with weather parameters on population build up showed that maximum and minimum temperatures and relative humidity in the morning were highly significant. Maximum and minimum temperatures had negative impact on population build up. However, the RH in the morning had a positive impact on population build up. The correlation between net sweep and light trap collection was very high (0.866), showing that either of them was enough to monitor the leaf folder population under field conditions.

Sabale *et al.* (2010) on the basis of the data of green leaf hopper for two species, namely, *Nephotettix nigropictus* (Nn) and *Nephotettix virescens* (Nv) reported that the first peak was observed for both the species during 38th to 41st standard meteorological week (SMW) the second peak was observed during 45th and the third peak was observed during 52nd to 2nd SMW (i.e. from last week of December to 2nd week of January of the succeeding year) for all study years. Overall, around six overlapping generations of green, leaf hopper appeared from March to November and were found most active during tillering to panicle initiation stages of the crop. The correlation studies between light trap net sweep collection with weather parameters on population build-up showed that lower minimum temperature, low rainfall and abundant sunshine had major impact on population build up of green leaf hopper for both the species.

Ahn and Park (2012) surveyed 5,730 insects, representing 268 species in 85 families and 12 orders. Sixty-three species of coleopterans were surveyed, followed by 60 species of Lepidoptera, and 37 species of Hemiptera.

2.4 Review of literature on pit fall trap

Barros *et al.* (2006) recorded that the coccinellidae was the most abundant of the complex of predators, with population levels following the fluctuation of a cotton aphid *Aphis gossypii* population. The suborder Heteroptera (Hemiptera) presented the highest diversity, with insects from 5 families, during 2001/02. The pitfall trap method was more efficient than visual evaluation.

Baker and Barmuta, (2006) studied environmental gradients like edge effects commonly where samples are collected at unequal distances within transects. This approach risks confounding species patterns caused by the environmental gradient with patterns resulting from the spatial arrangement of the sampling scheme. Spatial autocorrelation and depletion (reduced catch) have the potential to influence pitfall-trap collections of invertebrates. Readily available control data from a study of edge and riparian effects on forest litter beetles was used to assess autocorrelation and depletion effects. Four study sites were located in mature wet forest dominated by *Eucalyptus obliqua*, with mixed sclerophyllous and rain forest understorey in Tasmania, Australia. Data from control transects distant from the treatment transects located at habitat edges and streams were screened to determine whether the study design (pitfall traps at varying distances within transects) was imposing patterns on the data attributable to differential autocorrelation or depletion. Autocorrelation in species composition and assemblage structure was not detected within the 99 m transects. The abundance and species richness of beetles were not lower where traps were in closer proximity, indicating that the transect design was not causing measurable depletion or resulting in differential trap catch. These findings indicate that spatial autocorrelation and depletion are unlikely to impair further analyses of edge and riparian effects on litter beetles.

Sahra (2006) recorded that 244 species of spiders belonged to 33 families from Iran. Sixty two species, 44 genera and 8 families are reported for the first time from Iran in 2002-06. Spiders were collected from branches, leaves, flowers and trunks of trees and bushes, on the ground, under the stones and grasses by Steiner and Baggiolini method, bottle, aspirator, pitfall trap, pans and insect net. *Geolycosa altera* was found to be junior synonym of *Honga radiata*. Four species of Lycosid spiders were transferred to Trochosa: *T. austrocaspia*, *T. flavichelis*, *T. nava* and *T. persia*.

Santos *et al.* (2007) recorded that considering all pitfall trap types and sampling times, a total of 12937 individual edaphic arthropods belonging to 11 taxa were recovered. Smaller traps with preservative collected significantly more individuals than the other pitfalls tested. Larger and empty traps collected significantly more spiders and traps with preservative collected more beetles. Smaller and empty traps collected fewer individuals than the other trap types. Both Shannon's diversity and Pielou's evenness indexes were higher in the larger and empty traps and richness was higher in the smaller traps filled with water. The study of myrmecocenosis was emphasised because olive grove soil fauna was numerically dominated by Formicidae (56.6% of all organisms captured) belonging to 12 genera and 24 species; *Tapinoma nigerrimum*, *Messor barbarus*, *Cataglyphis hispanicus*, *Tetramorium semilaeve*, *Cataglyphis ibericus*, *Messor bouvieri* and *Camponotus cruentatus* were the most abundant ant species. Traps with preservative reached the highest accumulation of species for a small number of pitfalls when compared with the other pitfalls studied and a sampling effort of 20 samples is apparently sufficient to sample the greater part of the ant species of the olive grove. From this study, it seems that traps with preservative are the best choice to use in further studies concerning the epiedaphic fauna of the olive grove.

2.5 Review of literature on light trap

Vrieze (2008) registered 216 species of Noctuidae. The moths were attracted by a light tower with two black light-TL-lamps of 25 W each and a small light trap with one black light-TL-lamp of 6 W, that was left on the locality for the

whole night. During the last journey lure cords soaked with a solution of sugar-red wine were additionally used.

Dadmál and Khadakkar, (2014) recorded that the order Coleoptera showed a rich population i.e. 41.81% and 35.10% of the total collection for 2011-12 and 2012-13, respectively followed by Hemiptera 16.86% and 21.77% and Lepidoptera 12.96% and 12.89%, respectively. 19 species of scarab beetles belonging to 10 genera were found to be the prominent visitors for both the years.

Nowinszky (2004) reported that light trapping of insects depending on the environmental illumination, twilight polarization phenomena and the moon phases. The trapping data were taken of Hungarian national light-trap network. The important results are the followings: The Babinet-point, a polarization free spot of the sky at twilight, can be a role of orientation of insects. The height of the moon above the horizon is in negative correlation with the number of the caught insects. The maximum individual number of species was collected at various moon phases.

2.6 Review of literature on Berlese funnel

Chagnon *et al.* (1999) observed that the endogeic species were extracted from soil cores using Berlese-Tullgren funnels while epigeic species were collected using pit-light traps (Luminoc®). Comparisons of species presence, abundance, and dominance among sites and seasons were done using Sorensen's similarity coefficients and CANOCO. A total of 92 species from 7 families and 35 genera were identified. Species dominance and community structure differed according to humus types. Two groups of endogeic species were identified. The mor/mor-moder type group included *Folsomia penicula*, *Hypogastrura (Ceratophysella)* spp. Que., *Micrisotoma achromata*, *Onychiurus (Protaphorura) ?parvicornis*, *Onychiurus (Onychiurus)* sp. A Que. and *Onychiurus (Onychiurus)* sp. B Que. The mull/mull-moder type group included *Isotoma (Desoria) notabilis*, *Tullbergia (Tullbergia) silvicola*, *Tullbergia (Tullbergia) clavata*, and *Pseudosinella alba*. Such clear humus type relationships were not found among the epigeic species, but important seasonal changes in community structures were found for these species.

Rocheforta *et al.* (2005) reported that the total of 21 species representing 17 genera and nine families were identified of which four species were new records for the province of Quebec: *Brachystomella parvula*, *Mesaphorura simplex*, *Isotomodes productus*, and *Sphaeridia pumilis*. Turfgrass supports mainly three cosmopolitan species from the Isotomidae family, which represent 73.5% of all Collembola collected during the survey were *Parisotoma notabilis*, *Isotoma viridis*, and *Cryptopygus thermophilus*. Collembola were twice more abundant at the newly established site, but there were minor differences in species diversity between sites and years.

Smith *et al.* (2008) reported that the three methods for the particular vegetation types sampled and no significant differences in the size distributions of the earthworms and beetles. Proportionally fewer damaged earthworms were recorded in larger (25-25 cm) soil cores when compared with smaller ones (15-15 cm). Hand sorting has many benefits, including targeted extraction, minimum disturbance to the habitat and shorter sampling periods and may be the most appropriate method for studies of farmland biodiversity when a high number of soil cores need to be sampled.

According to Chagnon *et al.* (2000) results were consistent with those of a previous study relating collembolan species to chemical and biological soil parameters over several unamended sites covering a wide range of soil pH and a large territory. This confirmed the bioindicator value of collembolan communities for the assessment of soil acidity.

Deleporte and Tillier, (1998) observed changes in abundance and diversity differed between edaphic groups. Some effects of liming, like increase in numbers, were still present in NPKCa or limed plots, for example in pseudoscorpions (long-term effects). Lumbricid numbers (epigeic species) increased and remained higher in limed and NPKCa-treated plots than in N and control plots. Conversely, nitrogenous amendment did not induce similar changes, probably because of its soil acidifying effect. Nitrogenous amendment decreased numbers of oribatid mites and Collembola. These numbers are not different for limed and NPKCa plots in comparison with control ones.

2.7 Review of literature on pests of Karanja, *Pongamia pinnata*

Sahu (2014) screened six provenances of karanja, *Pongamia pinnata* namely Raipur, Ambikapur, Jabalpur, Nainpur, Zaheerabad and Keesaragutta, against fruit borer, *Ephestia* sp. and the common banded awl, *Hasora chromus*. Among these the provenance Jabalpur was found to be susceptible towards the major pest, the common banded awl, *H. chromus* while provenance Ambikapur was tolerant. Some of the other insects recorded were leaf webber, leaf blotch miner, leaf hopper, leaf gall maker, bark borer, leaf defoliator, beetle, green bug, gundhi bug, thrips, leaf folder, mealy bug, cow bug, hairy caterpillar, hawk moth and red cotton bug.

Anonymous (2010) reported about 30 insects feeding on *Pongamia pinnata*. Among them, the defoliator common banded awl (*Hasora chromus* Cramer) often attains serious proportions, in nurseries and young plantations. It is a butterfly belonging to the family Hesperiiidae and distributed in India, Pakistan, Nepal, Bhutan, Bangladesh, Myanmar and Sri Lanka. The pest infestation was found to be severe in the months of October – November, when the trees produce lot of young foliage. The larvae feed on young leaves voraciously.

Harinath *et al.* (2011) studied the eco-biology of the common banded awl *Hasora chromus*, Cramer (Lepidoptera ; Rhopalocera; Satyridae) from Southern Andhra Pradesh and reported it to be univalent, seasonal and endangered in Southern Andhra Pradesh. It was on wing from April to November and breeds almost with high frequency during the periods of monsoon and post monsoon seasons. The development from egg to adult took about 18 -24 days. There was no dormant stage in the life history. Success development of egg, larvae and pupae was 50-90%, 50-80% and 50-80% respectively during the afore said period.

Chavan and Saxena (2012) reported two hymenopteran parasitoids viz., *Xanthopimpla* sp.(Ichneumonidae) and *Brachymeria* sp. (Chalcididae) parasitizing the larvae of *Glyphodes negatalis*, a serious pest of karanja. The extent of parasitization by *Xanthopimpla* sp. ranged from 4.00% to 17.50 % and by

Brachymeria sp. ranged from 3.03% to 13.79%. The total extent of parasitization by parasitoid complex ranged from 7.69 % to 29.31%.

CHAPTER- III

METHODS AND MATERIALS

3.1 The study area

The present investigation entitled “Studies on the biodiversity of insect fauna at agro-forestry ecosystem of IGKV, Raipur (Chhattisgarh)” was conducted during October 2014 to April 2015. The experiment was conducted at the experimental research farm, Department of Forestry, Indira Gandhi Krishi Vishwavidyalaya, Raipur, C.G. (Fig.: 3.1) and in the laboratory of Department of Entomology.

3.1.1. Geographical location

Raipur, the place of investigation, is situated in the central part of Chhattisgarh at 21°14' N latitude, 81°38' E longitude and at an altitude of 298.15 meters from mean sea level.

3.1.2. Climate

The experimental site, Raipur comes under the seventh agro-climatic region of India i.e. eastern plateau and hills which is termed as sub humid with hot summer and cold winter. The source of rainfall is south western monsoon. It receives an average annual rainfall of 1200-1400 mm, mostly (85%) concentrating during the period of June to September. A few showers expected during winters and occasionally during summer months. May is the hottest and December is the coolest month of the year. The weekly maximum temperature rised up to 46°C during summer and minimum temperature reaches as low as to 6°C during winter season.

3.2 The present investigation was carried under the following objectives

- 3.2.1. Collection, identification and classification of various insect fauna under agro- forestry ecosystem of IGKV, Raipur (Chhattisgarh).
- 3.2.2. To determine the seasonal incidence of major insect pests of karanja, *Pongamia pinnata*.

Fig. 3.1: Experimental field of Agro-forestry



NATIONAL NETWORK ON INTEGRATED DEVELOPMENT OF JATROPHA AND KARANJA

Funding Agency
National Oilseed and Vegetable Oils Development Board
(Ministry of Agriculture, Govt. of India)

Agri-silvicultural Trial

Source : Raipur, Ambikapur, Jabalpur, Nainpur, Zaheerabad, Keesaragutta

Tree spacing : 6 x 6 m

Design : RBD

Replication : 3

Plantation : 20/09/2004

Intercropping : Rabi - Wheat; Kharif - Soybean

ALL INDIA COORDINATED RESEARCH PROJECT ON AGROFORESTRY

EVALUATION OF PERFORMANCE OF DIFFERENT COMPONENTS IN MULTITIER AGROFORESTRY SYSTEM ON VERTISOLS

बहुस्तरीय कृषिवानिकी में विभिन्न घटकों का कन्हार भूमि पर मूल्यांकन

DESIGN : SPLIT-SPLIT PLOT

REPLICATION : 6

SPECIES	SPACING	PLANTATION DATE
<i>Acacia mangium</i> (मिर्चलियाव) (मिर्चलियाव)	4 x 6 m	27.06.2003
<i>Emblica officinalis</i> (अम्वला)	4 x 6 m	26.07.2004
<i>Muraya koeninghii</i> (मीठी नीम)	4 x 3 m	27.06.2003
<i>Jatropha curcas</i> (रतनजोत)	4 x 3 m	27.06.2003

Under story crop- Turmeric (*Curcuma longa* var. Shilong) (हल्दी)

3.2.1. Collection, identification and classification of various insect fauna under agro-forestry ecosystem of IGKV, Raipur (Chhattisgarh)

Collection of various available fauna of insects were done by sweep nets for collecting flying insects, by pit fall traps for crawling insects, by light trap for nocturnal flying insects and by Berlese funnel for leaf litter and soil dwelling insects.

Collections were done at fortnightly intervals on 20 sweeps from 5 locations covering the experimental area of the agro-forestry field. (Fig.: 3.2.6)

Pit fall trap was installed at fortnightly interval at 5 locations using 4 different colours viz; yellow, blue, green and red plastic basins, filled with one fourth level of water. (Fig.: 3.2.5)

Light trap was installed for trapping nocturnal flying insects at proper location among the selected agro-forestry field. (Fig.: 3.2.3)

Berlese funnel (low cost and modified) using an ordinary study lamp was used to collect apterygote insects from leaf litter by placing over a sieve. The soil and leaf litter dwelling insects were collected in a plastic basin with some water kept under the sieve. (Fig.: 3.2.1)

The various species of insects thus collected were categorized order wise and tabulated to know their respective abundance in the Agro-forestry ecosystem.

3.2.1.1. Sweep net

A standard sweep net of 32 cm diameter was used for this purpose by taking 20 sweeps from 5 locations covering the experimental area of the agro-forestry field. 20 such sweeps constituted one sample. In total 5 samples were collected from field. The collected insects were killed in a potassium cyanide killing bottle and stored in 70% ethanol for later sorting and identification. The moths were, however, pinned and stored in wooden boxes (Cameron *et al.*, 1981; Wickramasinghe *et al.*, 2004; Leitao *et al.*, 2007)

Fig. 3.2: Collection of insects by various method



**Fig. 3.2.1: Low cost Berlese funnel
(Using study lamp)**

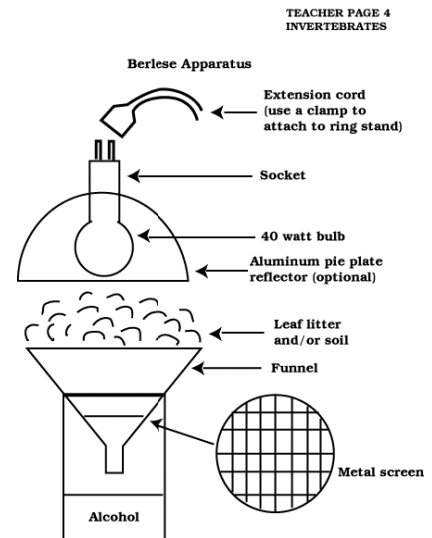


Fig. 3.2.2: Berlese funnel



Fig. 3.2.3: Light trap



Fig. 3.2.4: Pit fall trap



Fig. 3.2.5: Pit fall trap



Fig. 3.2.6: Sweep net collection



Fig. 3.2.7: Observing apterygote insects through trinocular microscope



Fig. 3.2.8: Hand collection of insects

3.2.1.2. Pit fall trap

Pitfall traps are excellent tools for detecting and monitoring the season long activity of walking and crawling soil and litter arthropods, especially those that are active at night. Pitfall traps can be used in sampling programs for row crops, orchards, turf, pastures, woodlands, and landscapes (Laub *et al.*, 2014).

In the present experiment for collecting crawling insect fauna pitfall traps of four different colors (red, yellow, green, blue) plastic basins were installed at 5 locations. The samples were labeled according to date and locality and stored properly. The insects were sorted in the laboratory under a digital trinocular microscope and then transferred into 70% alcohol until further identification (Oraze *et al.*, 1988; Paoletti *et al.*, 1999; Woin *et al.*, 2005).

3.2.1.3. Light trap

For nocturnal flying insects bucket type light traps having potassium cyanide bottle at the bottom as killing agent, equipped with 60 watts electric bulb were operated in proper location among the selected rice fields, from dusk to dawn and insect specimens were collected at weekly and fortnightly intervals from nurseries and crop fields in each locality, respectively. The height of the trap was adjusted according to height of the crop (Bowden, 1982; Yahiro and Yano, 1997).

3.2.1.4. Berlese funnel

Berlese funnel is an apparatus used to collect living organisms, particularly arthropods, from samples of soil and leaf litter. The funnel works by creating a temperature gradient over the sample such that mobile organisms move away from the higher temperatures and fall into a collecting basin provided with some water. The insects thus collected are observed under microscope and the preserved (Berlese, 1905). In the present studies modified Berlese funnel (low cost) was used by replacing the light sources by an ordinary study lamp with a sieve kept over a plastic basin like container provided with water. The lamp was kept burning overnight over the sieve containing leaf litter. The apterygote insects moved under neath to avoid the light and heat, fell through the sieve and were

collected in water filled basin. The insects were then sorted out under the microscope and counted order wise. (Fig.: 3.2.7)

3.2.1.5. Data analysis

The insects thus collected by various methods mentioned above were tabulated separately into various orders and were identified; and pooled analysis was also done.

The insect biodiversity was calculated using the Shannon-Weaver diversity indices (Shannon and Weaver, 1949) along with various multivariate analysis which are described as:

3.2.1.5.1. Shannon-Weaver diversity index (H) was used to determine the sample which has more abundant species. A species diversity study takes into account the number of species (species richness) and the importance of individuals in species (evenness) (Vandermeer, 1981). Shannon's index accounts for both abundance and evenness of the species present. The proportion of species i relative to the total number of species (p_i) was calculated, and then multiplied by the natural logarithm of this proportion ($\ln p_i$). The resulting product was summed across species, and multiplied by -1.

$$H = - \sum_{i=1}^s p_i \ln p_i$$

H is a more reliable measure as sampling size increases.

3.2.2. To determine the seasonal incidence of major insect pests of karanja, *Pongamia pinnata*

Observations were recorded on the provenance Jabalpur at fort nightly interval on the various species of insects and their number on six randomly selected trees. From each tree three branches were tagged for recording observations. (Fig.: 3.2.8) The data thus generated was tabulated and their fort nightly mean was computed. Graphical represented of the seasonal incidence was also prepared.

CHAPTER- IV

RESULTS AND DISCUSSION

The present investigation entitled “Studies on the biodiversity of insect fauna at agro-forestry ecosystem of IGKV, Raipur (Chhattisgarh)” was conducted during October 2014 to April 2015. The results are presented under following sub-headings:

- 4.1 Collection, identification and classification of various insect fauna under agro-forestry ecosystem of IGKV, Raipur (Chhattisgarh).
- 4.2 To determine the seasonal incidence of major insect pests of karanja, *Pongamia pinnata*.

4.1 Collection, identification and classification of various insect fauna under agro-forestry ecosystem of IGKV, Raipur (Chhattisgarh).

The collection of various available fauna of insects were done by different trapping methods viz. sweep net, pit fall trap, light trap and Berlese funnel at fort nightly intervals. Observations were carried out at the experimental area of agro-forestry field.

4.1.1. Sweep net

Apterygota

No collection of insects belonging to order collembola, protura, thysanura and diplura were seen by sweep net method.

Endopterygota

Among endopterygotes the maximum population was dominated by lepidoptera (133) followed by diptera (125) whereas, hymenopterans were recorded in minimum numbers (20). (Table: 4.1)

Exopterygota

Among exopterygotes the highest population was of hemiptera (62) followed by odonata (40) whereas, the lowest population was exhibited by embioptera (5).

Looking to the overall collection of insects by sweep net method as presented in table 4.1, highest number of insects collected belonged to order Lepidoptera followed by diptera, hemiptera, coleoptera, odonata, orthoptera and embioptera.

Arachnida

Mite (Acarina) population was not seen in the collections by sweep net method.

The Shannon' diversity index for insects collected by sweep net was calculated by the formula $H = -\sum_{i=1}^S p_i \ln p_i$, and was estimated to be 1.74. (Table: 4.1)

4.1.2. Pit fall trap

Pit fall trap was placed in the agro-forestry field using four different colored plastic basin type of containers viz., red, blue, green and yellow at five different locations (replications). The traps were collected the next day and the insects collected in various plastic containers were counted and sorted out colour-wise, and analysed using R.B.D. The order-wise details of the insects trapped in pit fall trap is as mentioned below:

Apterygota

No collection of insect population belonging to order collembola, protura, diplura and thysanura was noticed by pit fall method.

Endopterygota

As far as endopterygotes were concerned maximum insect population recorded was of hymenoptera (496) followed by diptera (220) whereas, the minimum population noticed was of coleoptera (120). (Table: 4.2)

Table 4.1: Percent composition of insects in agro-forestry field by sweep net collection

S.N.	Insect order	Total population	Seasonal mean	Percent composition of insects
1	Lepidoptera	133	13.3	30.02
2	Diptera	125	12.5	28.22
3	Hemiptera	62	6.2	14.00
4	Orthoptera	15	1.5	3.39
5	Hymenoptera	20	2	4.51
6	Odonata	40	4	9.03
7	Coleoptera	43	4.3	9.71
8	Embioptera	5	0.5	1.13
Grand total		443		
Shannon' diversity index			1.74	

Table 4.2: Percent composition of insects in agro-forestry field by pit fall trap

S.N.	Insect order	Total population	Seasonal mean	Percent composition of insects
1	Coleoptera	120	12	11.48
2	Hymenoptera	496	49.6	47.46
3	Hemiptera	96	9.6	9.19
4	Orthoptera	94	9.4	9.00
5	Isoptera	6	0.6	0.57
6	Dermaptera	13	1.3	1.24
7	Diptera	220	22	21.05
Grand total		1045		
Shannon' diversity index			1.45	

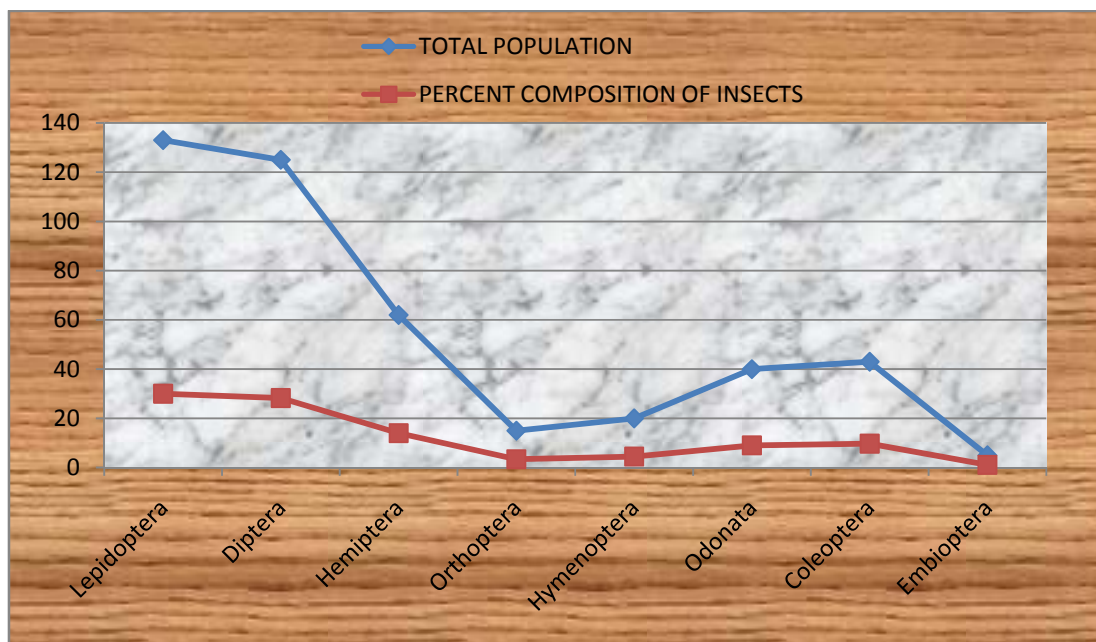


Fig 4.1: Overall and orderwise graphical representation of percent composition of insects of agro-forestry field collected by sweep net collection.

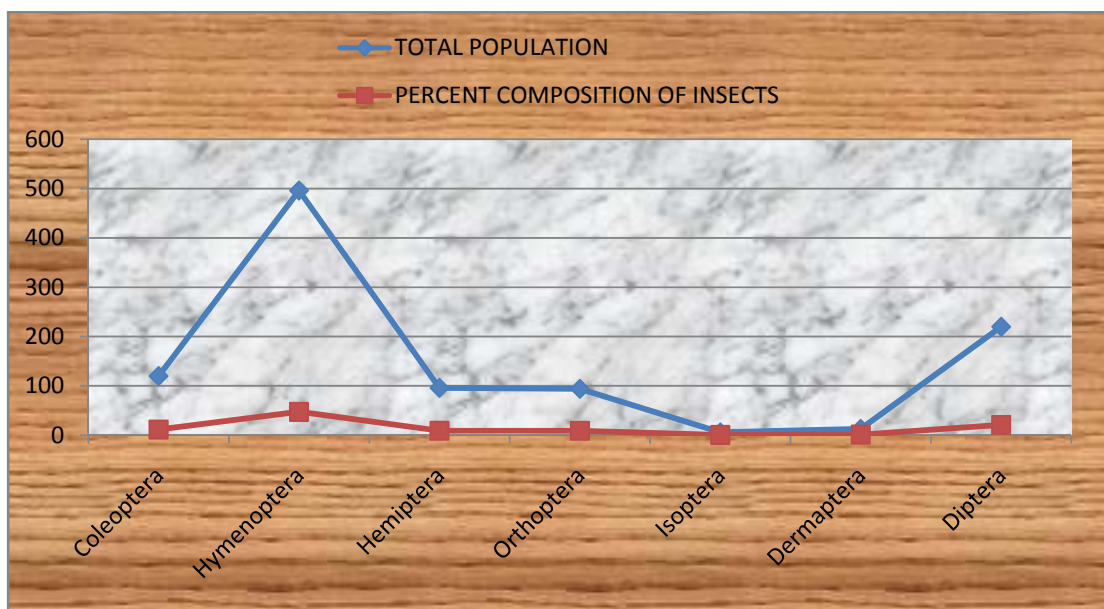


Fig 4.2: Overall and orderwise graphical representation of percent composition of insects of agro-forestry field collected by pit fall trap.

Table 4.3: Number of insects belonging to various orders collected at five different locations at the agro-forestry field by sweep net

Location	Lepidoptera	Diptera	Hemiptera	Orthoptera	Hymenoptera	Odonata	Coleoptera	Embioptera
L1	23	34	14	3	1	8	6	0
L2	21	25	12	5	3	6	16	1
L3	32	19	12	2	5	9	6	2
L4	25	16	14	2	8	9	2	1
L5	32	31	10	3	3	8	13	1
Total	133	125	62	15	20	40	43	5
Mean	26.6	25	12.4	3	4	8	8.6	1

Table 4.4: Pit fall trap

S.N.	Treatment	Coleoptera	Hymenoptera	Hemiptera	Orthoptera	Isoptera	Dermaptera	Diptera
1	Red	0.96	1.62	0.80	1.05	0.71	0.72	1.04
2	Blue	1.14	1.70	1.00	0.97	0.72	0.76	1.19
3	Green	1.09	1.87	1.11	0.98	0.73	0.75	1.36
4	Yellow	0.95	1.64	0.96	0.93	0.75	0.77	1.39
C.D.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.26
SE(m)	0.08	0.12	0.10	0.04	0.02	0.02	0.02	0.08
C.V.	17.75	15.04	22.63	8.61	5.19	6.23	14.92	

Exopterygota

In case of exopterygotes the highest insect population was observed of hemipterans (96) followed by orthoptera (94) while, the lowest population was exhibited by isoptera (6).

Arachnida

No mite population was recorded in pit fall trap.

The data presented in table 4.4, revealed significantly higher population of dipteran insects towards yellow pit fall trap. No significant choice in other orders towards any particular colour was noticed.

The Shannon' diversity index of the various insects belonging to different orders collected by pit fall trap was found to be 1.45. (Table: 4.2)

4.1.3. Light trap

Apterygota

No collection of insects belonging to apterygotes i.e. collembola, protura, diplura and thysanura was seen in light trap.

Endopterygota

Among endopterygotes maximum population recorded was of diptera (62) followed by lepidoptera (43) whereas, minimum population was noticed in neuroptera (4). (Table: 4.5)

Exopterygota

As far as exopterygotes were concerned highest insect population was dominated by order hemiptera (81) followed by ephemeroptera (10) while, lowest population was exhibited by orthoptera (4).

Arachnida

Mite population was not observed in light trap.

The Shannon' diversity index calculated for the various insects belonging to different orders collected by light trap was computed to be 1.48.

Overall collection of insects by light trap as presented in table 4.5, revealed that it was dominated by order hemiptera (38.05%) followed by diptera (29.11%), Lepidoptera (20.19%) and coleoptera (4.23%) which is contradictory to the findings of Dadmal and Khadakkar 2014, who mentioned that coleoptera was the most dominant order in light trap collection.

4.1.4. Berlese funnel method

Apterygota

Berlese funnel is an efficient method for observing apterygote insects and in the present studies maximum population recorded belonged to order of collembola (34) followed by protura (26) whereas, the minimum population was noticed of diplura (15). No insects belonging to order thysanura was recorded. These findings are in agreement with Rocheforta *et al.*,2005, who also mentioned that collembola were most abundant in the newly established site of the province Quebec.

Endopterygota

Among endopterygotes the maximum population recorded was of hymenoptera (123) followed by coleoptera (31) while lowest population was noticed of diptera (13).

Exopterygota

Among exopterygotes, the only insects recorded was of order isoptera with a population of 33 insects.

Table 4.5: Percent composition of insects in agro-forestry field by light trap method

S.N.	Insect order	Total population	Seasonal mean	Percent composition of insects
1.	Lepidoptera	43	2.15	20.19
2.	Hemiptera	81	4.05	38.03
3.	Diptera	62	3.1	29.11
4.	Coleoptera	9	0.45	4.23
5.	Orthoptera	4	0.2	1.88
6.	Ephemeroptera	10	0.5	4.69
7.	Neuroptera	4	0.2	1.88
Grand total		213		
Shannon' diversity index			1.48	

Table 4.6: Percent composition of insects in agro-forestry field by berlese funnel method

S.N.	Insect order	Total population	Seasonal mean	Percent composition of insects
1.	Isoptera	19	6.33	5.76
	Worker Termite			10
	Soldier Termite	14	4.66	4.24
2.	Protura	26	8.66	7.88
3.	Diplura	15	5.00	4.55
4.	Collembola	34	11.33	10.30
5.	Hymenoptera	92	30.66	27.88
	Saprophytic ants			9.39
	Red Ants	31	10.33	
6.	Diptera	13	4.33	3.94
7.	Coleoptera	31	10.33	9.39
8.	Acarina	55	18.33	16.67
Grand total		330		
Shannon' diversity index			1.82	

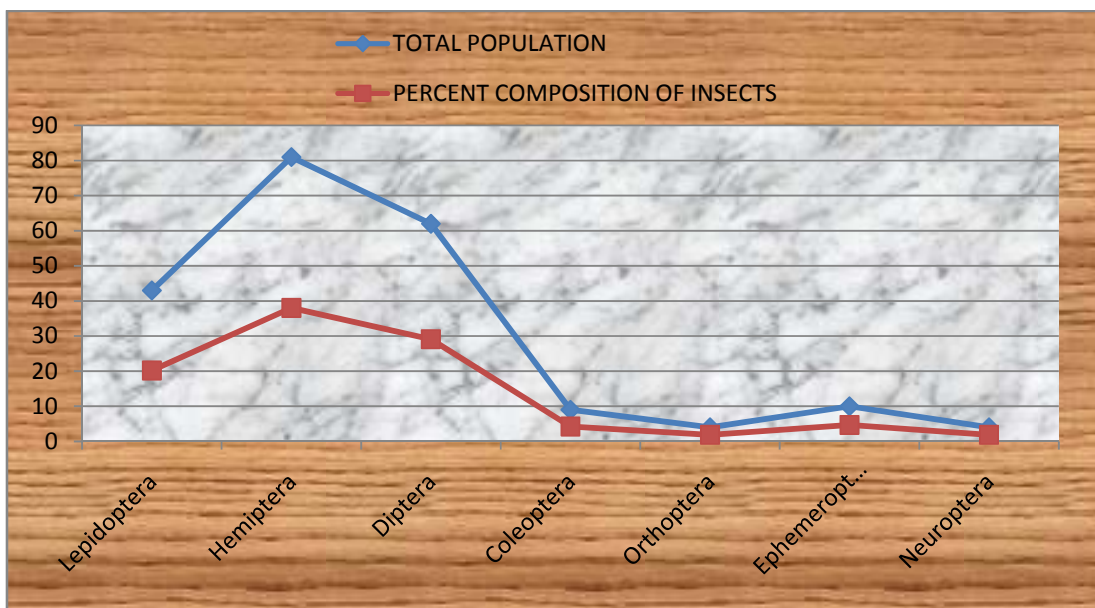


Fig 4.3: Overall and orderwise graphical representation of percent composition of insects of agro-forestry field collected by light trap.

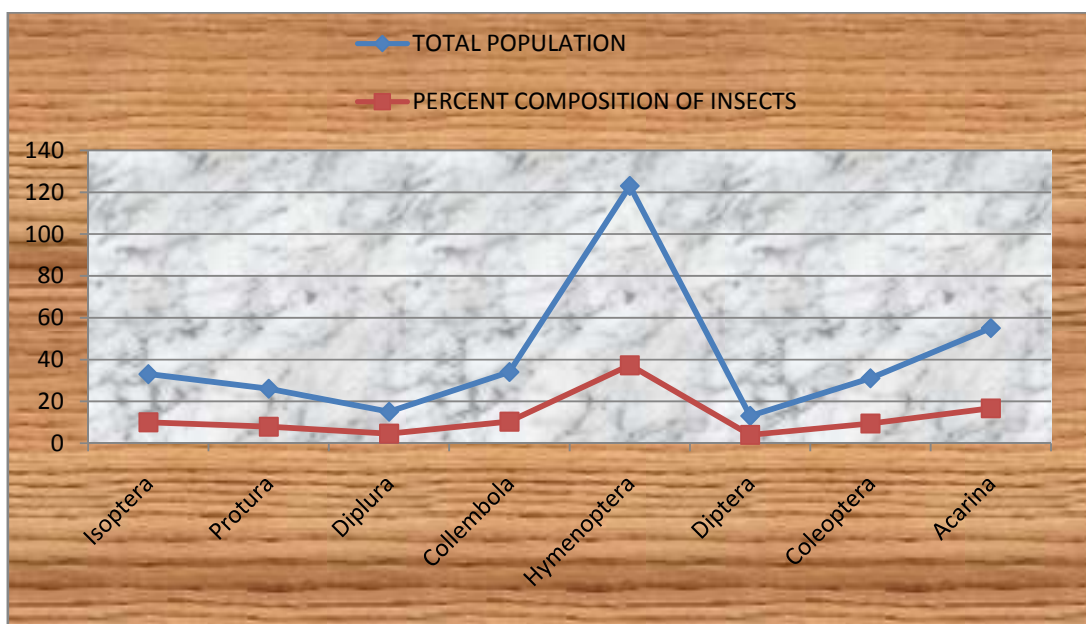


Fig 4.4: Overall and orderwise graphical representation of percent composition of insects of agro-forestry field collected by Berlese funnel method.

Table 4.7: Light trap (Weekly Observation)

S.N.	Order	Standard meteorological weeks																					Total
		45	46	47	48	49	50	51	52	01	02	03	04	05	06	07	08	09	10	11	12		
1.	Lepidoptera	3	3	4	2	4	2	1	2	0	1	3	2	2	2	1	3	3	0	4	1	43	
2.	Hemiptera	5	5	3	6	3	3	4	4	0	3	8	6	6	3	2	5	5	4	3	3	81	
3.	Diptera	3	8	3	4	4	2	4	0	2	3	4	4	4	2	3	3	1	4	2	2	62	
4.	Coleoptera	2	1	0	0	0	1	2	1	0	0	0	0	0	1	0	0	0	1	0	0	9	
5.	Orthoptera	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	4	
6.	Ephemeroptera	1	0	2	2	0	2	1	0	0	0	1	0	0	0	0	1	0	0	0	0	10	
7.	Neuroptera	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	4	
Total		15	17	14	14	11	11	12	9	2	7	16	12	12	8	6	12	10	10	9	6	(213)	

Table 4.8: Insect collected from litter of agro-forestry field by Berlese funnel

Location	Isoptera (Termite)		Protura	Diplura	Collembola	Hymenoptera (Ants)		Diptera (Maggot)	Coleoptera	Acharina (Mites)
	Worker	Soldier				Saprophytic	Red			
1	5	3	12	7	13	35	8	3	10	17
2	8	7	6	3	11	27	12	6	12	20
3	6	4	8	5	10	30	11	4	9	18
Total	19	14	26	15	34	92	31	13	31	55
Mean	6.33	4.66	8.66	5.00	11.33	30.66	10.33	4.33	10.33	18.33

Location 1: Sample collected from bamboo leaf litter of agro-forestry field.

Location 2: Sample collected from *Acacia mangium* leaf litter of agro-forestry field.

Location 3: Sample collected from teak leaf litter of agro-forestry field.

Arachnida

Mite population (55) was also recorded by Berlese funnel. (Table: 4.6)

The Shannon' diversity index computed for the collection of insects under different orders by Berlese funnel was estimated to be 1.82.

On the basis of overall collection of insects by various methods in the agro-forestry field ecosystem revealed maximum number of insects belonging to order hymenoptera (639) followed by diptera (420) while minimum population observed was of neuropterans (4). As far as collection of non-insects was concerned only mite population (55) was noticed. As far as percent composition of overall insects recorded by various methods was concerned maximum and minimum population recorded was of hymenoptera i.e. (31.46%) and neuroptera i.e. (0.20%), while percent composition of mites was 2.71%. (Table: 4.9)

Thus, looking to the overall collection of insects trapped by various methods as presented in table 4.9, clearly indicates that maximum number of insects were collected in pit fall trap (1045) followed by sweep net (443), Berlese funnel (330) and light trap (213). This indicates that crawling insects dominated the fauna of agro-forestry. As far as percent composition was concerned, among the total insects caught by pit fall 47.46 percent belonged to hymenoptera and among the hymenopterans, Formicidae was the dominant order. These findings are in accordance with Santos *et al.* 2007, who also opined that 56.60% of all the organisms captured by pit fall trap in the olive grove soil fauna was dominated by Formicidae.

Hence, from the present studies it can be concluded that the insect biodiversity of the agro-forestry field of IGKV, Raipur was composed of representatives from fifteen orders namely; collembola, protura, diplura, lepidoptera, diptera, coleoptera, neuroptera, hymenoptera, hemiptera, orthoptera, ephemeroptera, odonata, embioptera, isoptera and dermaptera (fig: 4.5). No representation of insects from the order thysanura, plecoptera, grylloblattodea, phasmida, zoraptera, psocoptera, mallophaga,

Table 4.9: Overall population of insects at the agro-forestry ecosystem collected by various methods.

Different trapping methods	Various insect and mites fauna present under agro-forestry ecosystem																Total	
	Apterygota			Endopterygota						Exopterygota						Arachnida		
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P		
Sweep net	0	0	0	133	125	43	0	20	62	15	0	40	5	0	0	0	443	
Pit fall trap	0	0	0	0	220	120	0	496	96	94	0	0	0	6	13	0	1045	
Light trap	0	0	0	43	62	9	4	0	81	4	10	0	0	0	0	0	213	
Berlese funnel	34	26	15	0	13	31	0	123	0	0	0	0	0	33	0	55	330	
Total population	34	26	15	176	420	203	4	639	239	113	10	40	5	39	13	55	(2031)	
Percent Composition	1.67	1.28	0.74	8.67	20.68	10	0.2	31.46	11.77	5.56	0.49	1.97	0.25	1.92	0.64	2.71		
Shannon' diversity index																	2.04	

Where; A= Collembola, B= Protura, C= Diplura, D= Lepidoptera, E= Diptera, F= Coleoptera, G= Neuroptera, H= Hymenoptera, I= Hemiptera, J= Orthoptera, K= Ephemeroptera, L= Odonata, M= Embioptera, N= Isoptera, O= Dermaptera, P= Acarina.

Table 4.10: Seasonal incidence of insect pests of karanja, *Pongamia pinnata*.

S.N.	Plant	Leaf blotch miner	Plant sucking bug	Hairy caterpillar	Leaf hopper
1	P1	9.57	0.03	0.00	0.33
2	P2	16.03	0.03	0.00	0.73
3	P3	8.50	0.07	0.20	0.77
4	P4	11.30	0.07	0.03	0.53
5	P5	9.27	0.07	0.00	0.63
6	P6	13.77	0.03	0.00	0.20
Total		68.43	0.30	0.23	3.20

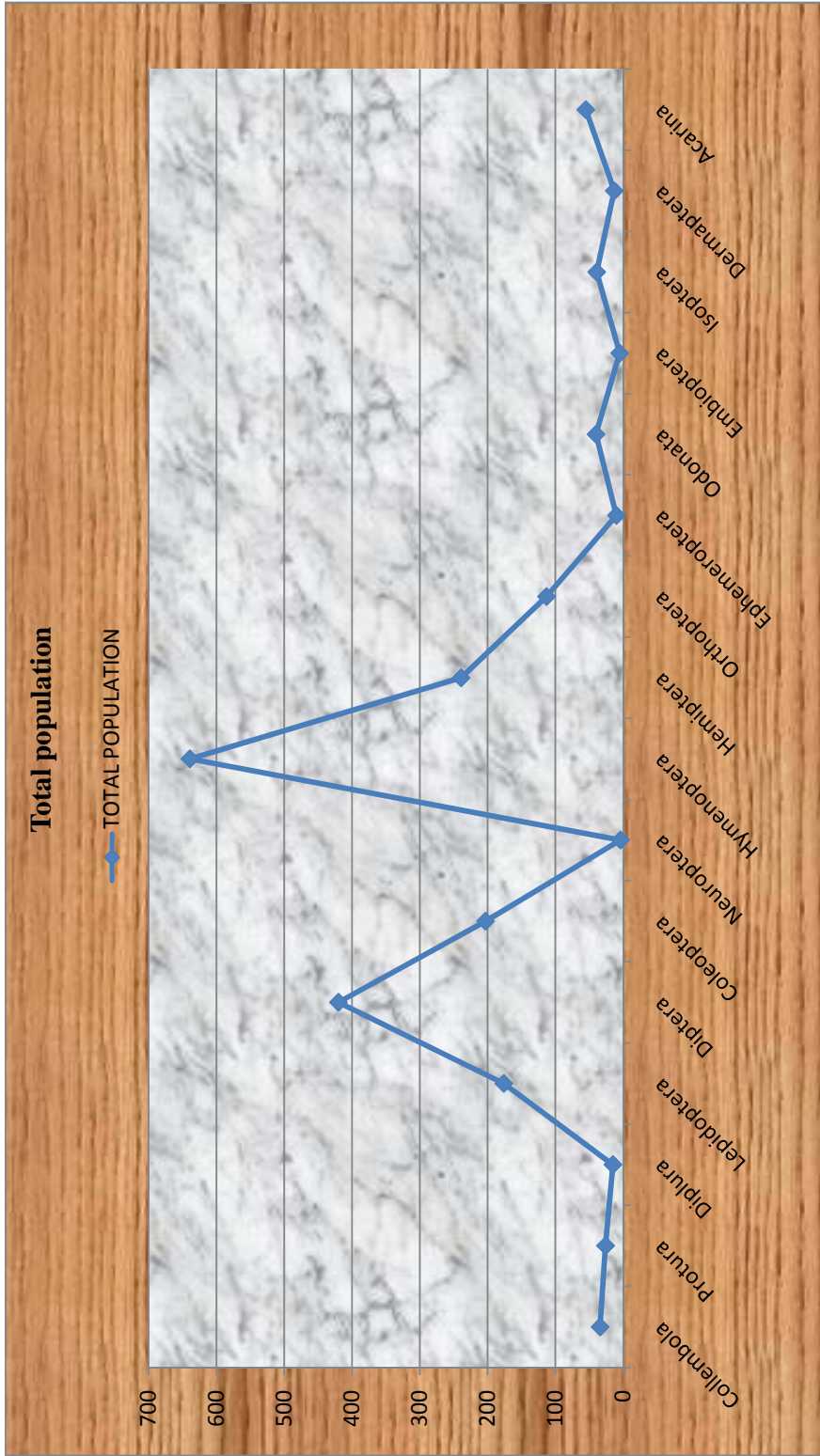


Fig 4.5: Total number of insects belonging to various order collected by different methods.

siphunculata, thysanoptera, mecoptera, trichoptera, siphonaptera and strepsiptera was observed.

The Shannon' diversity index calculated for the overall insects trapped by various trapping methods was 2.04, which is quiet high, showing that the biodiversity of the agro-forestry field is rich and represented by various insects of different orders.

The list of various insects trapped by different trapping methods during the present studies is given in table 4.11; in which included 87 insects belonging to different orders.

4.2 To determine the seasonal incidence of major insect pest of karanja, *Pongamia pinnata*.

In the present studies, four insect pests were observed, namely the leaf blotch miner, plant sucking bug, hairy caterpillar, *Euproctis* sp. and leaf hopper,

4.2.1. Leaf blotch miner, *Acrocerops brongniardella* Fabr. (Lepidoptera: Gracillaridae)

Blotch miner, *A. brongniardella* is a very serious and common pest of karanja, *P. pinnata*. The larvae makes circular blotches on the upper (dorsal) surface of the leaves (Fig.: 4.7.2). On an average 4-17 blotches were observed per three leaves and sized on an average about 8-20 mm in length and 4-12 mm in width (Fig.: 4.7.1). There was only a single larvae/blotch. Severe infestations led to reduction in the photosynthetic area of the leaves thus reducing growth and vigour of the plants. The full grown larvae was slender, minute, orangish-yellow with large black head measuring about 4-6 mm in length. The peak activity of blotch miner was noticed during the 2nd fort night of December with an average population of 18.28 blotches/plant; and lowest 4.83 blotches/plant during 1st fort night of February. The population again showed a rising trend in the 2nd fort nightly of February after which it declined in the following months. (Table: 4.10.1)

4.2.2. Plant sucking bug (Unidentified)

Both nymphs and adults sucked the sap of young leaves. Body of the bugs was green in color with brown colored wing similar to gundhi bug (Fig.: 4.7.7). Adult bug measured about 12.0 to 15.0 mm in length and 3.0-4.0 mm in width. It was also observed that the bugs secreted a green colored liquid having a strong offensive odor. The activity of this insect was noticed from the 2nd fort night of November with a mean population of 0.17 adults & nymphs/plant and increased to a maximum of 0.22 adults & nymphs/plant in the 1st fort night of December, which later decreased with no population at all in the following months from January to March. (Table: 4.10.2)

4.2.3. Hairy caterpillar, *Euproctis* sp.

Hairy caterpillar, *Euproctis* sp. was noticed although a very low population was seen. Early instar larvae of hairy caterpillar, *Euproctis* sp. fed on the green part of the leaves and skeletonized them but later instar larvae completely ate the leaves along with soft apical shoots of plants (Fig.: 4.7.8). The activity of *Euproctis* sp. was seen from the 2nd fort night of November with a population of 0.11 larvae/plant and rose to 0.17 larvae/plant in the 2nd fort night of December. No population of *Euproctis* sp. was observed in the following months up to march. (Table: 4.10.3)

4.2.4. Leaf hopper (Unidentified)

Leaf hopper was one of the major sucking pests of karanja, *P. Pinnata*. Both nymphs and adults were found sucking the young leaves and shoots of the plants (Fig.: 4.7.5). They also secreted 'honey dew' on which sooty mould was seen as black patches, due to which plants appeared sickly and vigour was affected. Adult leaf hopper of karanja measured about 4-5 mm long with light green to dark green with black colored eyes and two black spots on the dorsal side of the prothorax. The population of leaf hopper started building up from the 1st fort night of December with 1.22 adults & nymphs/plant and increasing up to 1.61 adults & nymphs/plant in the forth coming fort nights of January, particularly in the 1st fort night, and thereby

decreasing to 0.89 adults & nymphs/plant in the 2nd fort night of January and with nil population during February and March. (Table: 4.10.4)

The overall seasonal activity of various insect pest as presented in Fig. 4.6, clearly shows that maximum activity of leaf blotch miner and plant sucking bug was noticed in highest numbers during 1st FN of December, while peak incidence of hairy caterpillar, *Euproctis* sp. was noticed during the 2nd FN of December, while a poor population of leaf hopper with its highest activity was observed during the 1st FN of January.

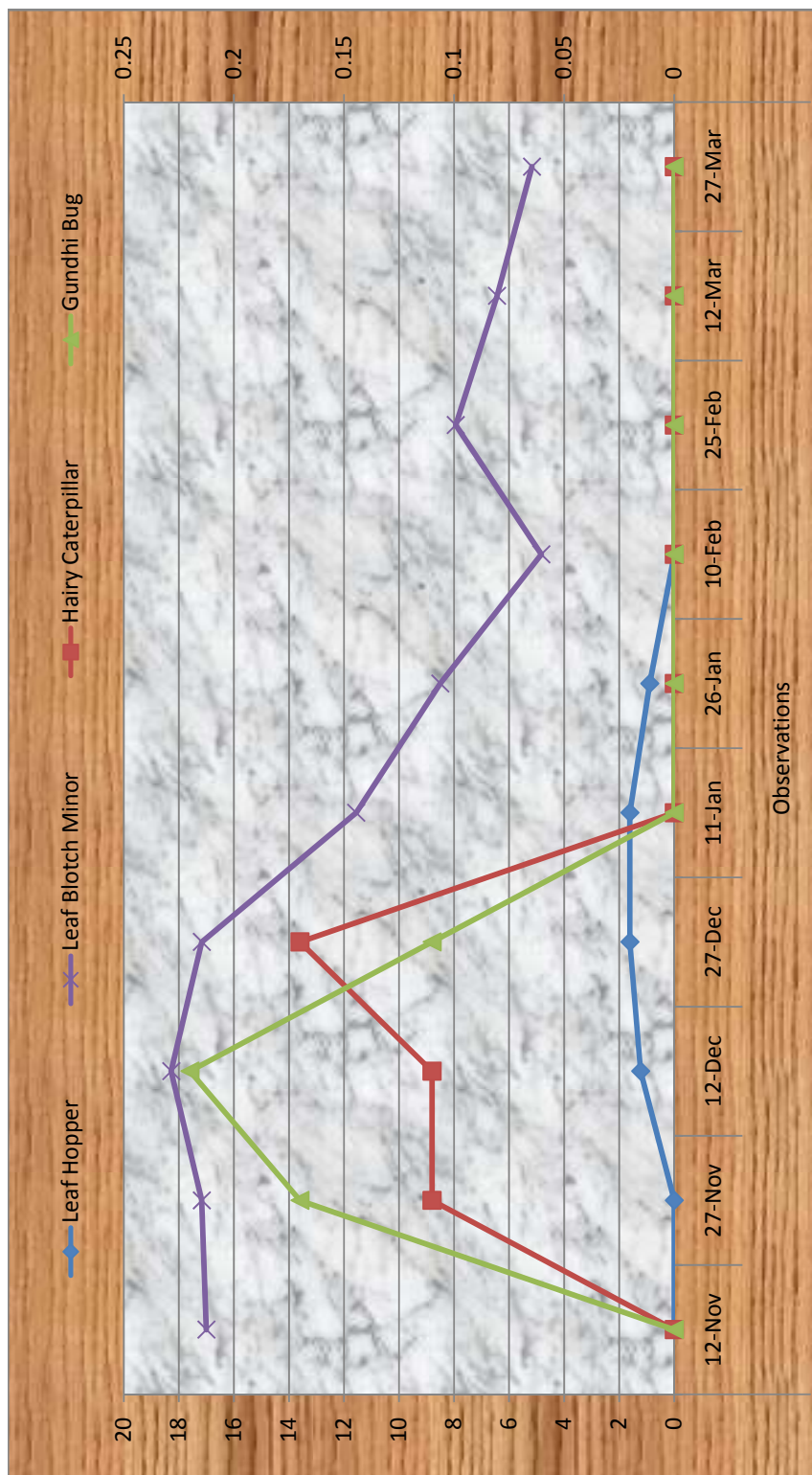


Fig 4.6: Seasonal incidence of insect pest of Karanja, *Pongamia pinnata*

Fig. 4.7: Various insect pests of karanj, *Pongamia pinnata*



Fig. 4.7.1: leaf infested by leaf blotch miner



Fig. 4.7.2: larva of leaf blotch miner

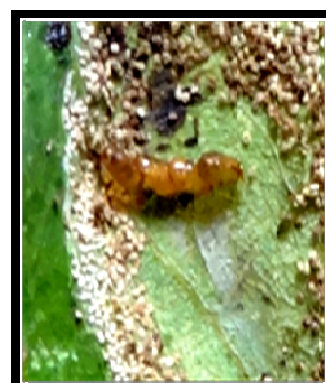


Fig. 4.7.3: pupa of leaf blotch miner



Fig. 4.7.4: Leaf damage caused by leaf hopper



Fig. 4.7.5: Leaf hopper

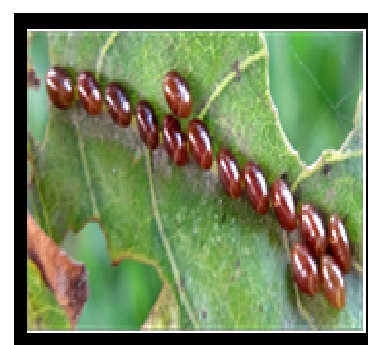


Fig. 4.7.6: Eggs of plant sucking bug



Fig. 4.7.7: Adults of plant sucking bug

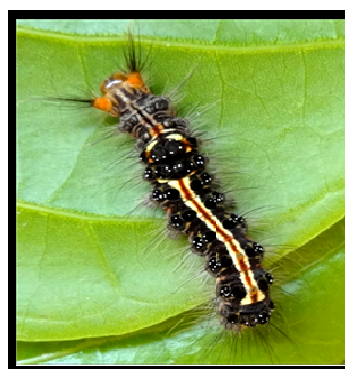


Fig. 4.7.8: larva of hairy caterpillar



Fig. 4.7.9: Adult of hairy caterpillar

Table 4.11: Various insect species representing insect biodiversity collected at the agro-forestry field of IGKV, by different methods

S.N.	Insect name	Scientific name	Family	Order
1.	Fruit sucking moth	<i>Ophideres meterna</i>	Noctuidae	Lepidoptera
2.	Citrus butter fly	<i>Papilio demolis</i>	Papilionidae	Lepidoptera
3.	Sphinx caterpillar	<i>Manduca quinguemaculata</i>	Sphingidae	Lepidoptera
4.	Horned caterpillar	<i>Melanitis leda ismidiae</i>	Satyriidae	Lepidoptera
5.	Weed killer	Unidentified	Nymphalidae	Lepidoptera
6.	Weed killer	Unidentified	Nymphalidae	Lepidoptera
7.	Milky weed butter fly	<i>Euploea core</i>	Denaidae	Lepidoptera
8.	Bihar hairy caterpillar	<i>Spolaractia oblique</i>	Arctiidae	Lepidoptera
9.	Noctuid moth	<i>Trigonades hyppasi</i>	Noctuidae	Lepidoptera
10.	Hawk moth	<i>Hex convoluli</i>	Sphingidae	Lepidoptera
11.	Tiger moth	<i>Ereibrus</i> sp.	Ereibridae	Lepidoptera
12.	Aristalochia weed killer	<i>Papilio aristalochia</i>	Papilionidae	Lepidoptera
13.	Citrus fruit sucking moth	<i>Orthris ancilla</i>	Noctuidae	Lepidoptera
14.	Looper	Unidentified	Geometridae	Lepidoptera
15.	Eye spotted butterfly	<i>Chidreana children</i>	Nymphalidae	Lepidoptera
16.	Looper	Unidentified	Geometridae	Lepidoptera
17.	Milky weed butterfly	<i>Danaus chrysippus</i>	Daniidae	Lepidoptera
18.	Hawk moth	<i>Hippotion</i> sp.	Sphingidae	Lepidoptera
19.	Bag worm	<i>Psyche</i> sp.	Psychidae	Lepidoptera
20.	Grass weed killer	<i>Eurema yakabe</i>	Peiridae	Lepidoptera
21.	Micronia moth	<i>Micronia aculeata</i>	Geometridae	Lepidoptera
22.	Ground beetle	<i>Anthia sexguttata</i>	Carabidae	Coleoptera
23.	Ground beetle	<i>Cosmoidea indica</i>	Carabidae	Coleoptera
24.	Ground beetle	<i>Calastoma indica</i>	Carabidae	Coleoptera
25.	Dung roller	<i>Scarabacus</i> sp.	Searabaeidae	Coleoptera
26.	Dung roller	<i>Helicoprobus bucephalus</i>	Searabaeidae	Coleoptera
27.	Rose chaffer beetle	<i>Chilaloba acuta</i>	Searabaeidae	Coleoptera
28.	Ground beetle	<i>Calosa Mamadurae</i>	Carabidae	Coleoptera

29.	Ground beetle	<i>Omphra</i> sp.	Carabidae	Coleoptera
30.	Tortise beetle	<i>Chirada sexpunctata</i>	Chrysomellidae	Coleoptera
31.	Blistar beetle	<i>Myllabris pustulata</i>	Meloidae	Coleoptera
32.	Stem borer	<i>Bactocera rufomaculata</i>	Cerambycidae	Coleoptera
33.	Diving beetle	<i>Dytiscus marginalis</i>	Dytiscidae	Coleoptera
34.	Chrysomellid beetle	Unidentified	Chrysomellidae	Coleoptera
35.	Water scavenger	<i>Hydrophilus triangularis</i>	Hydrophilidae	Coleoptera
36.	Roove beetle	<i>Pearderus fuseipes</i>	Staphylinidae	Coleoptera
37.	Leady bird beetle	<i>Adalia bipunctata</i>	Coccinellidae	Coleoptera
38.	Click beetle	<i>Agroites</i> sp.	Eleteridae	Coleoptera
39.	Flea beetle	<i>Chaetocnerrus</i> sp.	chrysomillidae	Coleoptera
40.	Red ant	<i>Oecophilla smaragdina</i>	Formicidae	Hymenoptera
41.	Caepenter ant	<i>Camponotus compestris</i>	Formicidae	Hymenoptera
42.	Red ant	<i>Monomorium indicum</i>	Formicidae	Hymenoptera
43.	Wasp/Yellow Jacket	<i>Vespa cincta</i>	Vespidae	Hymenoptera
44.	Wasp/Yellow Jacket	<i>Vespa orientalis</i>	Vespidae	Hymenoptera
45.	Paper wasp	<i>Polister</i> sp.	Vespidae	Hymenoptera
46.	Ichneumonid wasp	<i>Eriborus</i> sp.	Ichneumonid	Hymenoptera
47.	Carpender bee	<i>Xylocopa</i> sp.	Xylocopodea	Hymenoptera
48.	Bees	<i>Apis dorsata</i>	Apidae	Hymenoptera
49.	Sphecicid wasp	<i>Trypoxylon</i> sp.	Sphecidae	Hymenoptera
50.	Blind ants	<i>Dorylus indicus</i>	Formicidae	Hymenoptera
51.	Stinging ants	<i>Leptogenyp</i> sp.	Formicidae	Hymenoptera
52.	Digger wasp	<i>Motes</i> sp.	Sphecidae	Hymenoptera
53.	Canthoconid bug	<i>Canthocorus percellota</i>	Pentatomidae	Hemiptera
54.	Shield bug	<i>Chrysocoris stollii</i>	Scutellaridae	Hemiptera
55.	Kissing bug	<i>Isydes heros</i>	Reduviidae	Hemiptera
56.	Flattidae	<i>Phormia viridula</i>	Flattidae	Hemiptera
57.	Broad headed bug	<i>Leptacoris aratoma</i>	Alydidae	Hemiptera
58.	Milky weed bug	<i>Phyrracoris apterus</i>	Pyrracoridae	Hemiptera
59.	Stink bug	<i>Aspangophus</i> sp.	Pentatomidae	Hemiptera

60.	Green stink bug	<i>Nazara viridula</i>	Pentatomidae	Hemiptera
61.	Gaint water bug	<i>Belastoma indica</i>	Belastomatidae	Hemiptera
62.	Cow bug	<i>Otinotus oneratus</i>	Membracidae	Hemiptera
63.	Nacorid bug	Unidentified	Nacoridae	Hemiptera
64.	Syrphid fly	<i>Syrphus</i> sp.	Syrphidae	Diptera
65.	Horse fly	<i>Tabanus striatus</i>	Tabanidae	Diptera
66.	Mosquito	<i>Culex</i> sp.	Culicidae	Diptera
67.	Cecidomyid fly	<i>Rabdophaga</i> sp.	Cecidomyiidae	Diptera
68.	Fungus knot	<i>Mycetophila</i> sp.	Mycetophilidae	Diptera
69.	Blow fly	<i>Calliphora</i> sp.	Calliphoridae	Diptera
70.	House fly	<i>Musca</i> sp.	Muscidae	Diptera
71.	Robber fly	<i>Asilus indicus</i>	Asilidae	Diptera
72.	Blood midge	<i>Chironomus dorsalis</i>	Chironomidae	Diptera
73.	Ant lion	<i>Myrmelion farnicarius</i>	Myrmeliontidae	Neuroptera
74.	Brown lace wing	<i>Hemerobius stigma</i>	Hemerobiidae	Neuroptera
75.	Green lace wing	<i>Chrysoperla cornea</i>	Chrysopidae	Neuroptera
76.	Mole cricket	<i>Gryllotalpa gryllotalpa</i>	Gryllotalpidae	Orthoptera
77.	Cricket	<i>Gryllus bimaculatus</i>	Gryllidae	Orthoptera
78.	Field Cricket	<i>Gryllus gryllus</i>	Gryllidae	Orthoptera
79.	Cone grass hopper	<i>Neoconocephalus indicus</i>	Tettiganidae	Orthoptera
80.	Ak grasshopper	<i>Poakilocerus pictus</i>	Phyrgomorphidae	Orthoptera
81.	Solitary locust	<i>Cystecanthecriis tatarica</i>	Acrididae	Orthoptera
82.	Long horned gh.	<i>Paracryrtophilus</i> sp.	Tettigonidae	Orthoptera
83.	Dragon fly	<i>Pentella flaviscense</i>	Aeshnidae	Odonata
84.	Dragon fly	<i>Libulella</i> sp.	Libulellidae	Odonata
85.	Damsel fly	<i>Lestex vigelax</i>	Calypterigidae	Odonata
86.	Spring tail	<i>Sminthurus viridis</i>	Sminthuridae	Collembola
87.	May fly	<i>Ephemera annadale</i>	Ephemeridae	Ephemeroptera



Fig. 4.8: Moths and butterflies collected during the studies



Fig. 4.9: Moths and butterflies collected during the studies

CHAPTER- V

**SUMMARY, CONCLUSION
AND SUGGESTIONS FOR FUTURE WORK**

The present investigation entitled “Studies on the biodiversity of insect fauna at agro-forestry ecosystem of IGKV, Raipur (Chhattisgarh)” was conducted during October 2014 to April 2015. The experiment was conducted at the experimental research farm, Department of Forestry, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) and in the laboratory of Department of Entomology. The collection of various available fauna of insects were done by sweep nets for collecting flying insects, by pit fall traps for crawling insects, by light trap for nocturnal flying insects and by Berlese funnel for leaf litter and soil dwelling insects. The seasonal incidence of major insect pest of karanja, *Pongamia pinnata* were recorded on the provenance Jabalpur at fort nightly interval on the various species of insects and their number on six randomly selected trees. From each tree three branches were tagged for recording observations.

SUMMARY

The results are summarized under following sub-headings:

- 5.1 Collection, identification and classification of various insect fauna under agro-forestry ecosystem of IGKV, Raipur (Chhattisgarh).
- 5.2 To determine the seasonal incidence of major insect pest of karanja, *Pongamia pinnata*.

5.1 Collection, identification and classification of various insect fauna under agro-forestry ecosystem of IGKV, Raipur (Chhattisgarh).

The collection of various available fauna of insects were done by different trapping methods viz. sweep net, pit fall trap, light trap and Berlese funnel at fort

nightly intervals. Observations were carried out at the experimental area of agro-forestry field.

On the basis of overall collection of insects by various methods in the agro-forestry field ecosystem revealed maximum number of insects belonging to order hymenoptera (639) followed by diptera (420) while minimum population observed was of neuropterans (4). As far as collection of non-insects was concerned only mite population (55) was noticed. As far as percent composition of overall insects recorded by various methods was concerned maximum and minimum population recorded was of hymenoptera i.e. (31.46%) and neuroptera i.e. (0.20%), while percent composition of mites was 2.71%. (Table: 5)

Looking to the overall collection of insects trapped by various methods as presented in Table 5, clearly indicates that maximum number of insects were collected in pit fall trap (1045) followed by sweep net (443), Berlese funnel (330) and light trap (213). This indicates that crawling insects dominated the fauna of agro-forestry. As far as percent composition was concerned, among the total insects caught by pit fall 47.46 percent belonged to hymenoptera and among the hymenopterans, formicidae was the dominant order.

5.2 To determine the seasonal incidence of major insect pests of karanja, *Pongamia pinnata*.

In the present studies, four insect pests were observed, namely the leaf blotch miner, plant sucking bug, hairy caterpillar, *Euproctis* sp. and leaf hopper,

The overall seasonal activity of various insect pests is presented in Fig. 6, which clearly shows that maximum activity of leaf blotch miner and plant sucking bug was noticed in highest numbers during 1st FN of December, while peak incidence of hairy caterpillar, *Euproctis* sp. was noticed during the 2nd FN of December, while a poor population of leaf hopper with its highest activity was observed during the 1st FN of January.

Conclusion

The findings of the investigation entitled “Studies on the biodiversity of insect fauna at agro-forestry ecosystem of IGKV, Raipur (Chhattisgarh)” are as mentioned below:

1. Collection of insects by various methods in the agro-forestry field ecosystem revealed maximum number of insects belonging to order hymenoptera (639) while minimum population observed was of neuropterans (4). Looking to the overall collection of insects trapped by various methods, clearly indicates that maximum number of insects were collected in pit fall trap (1045) followed by sweep net (443). This indicates that crawling insects dominated the fauna of agro-forestry. The present studies also revealed that representatives of fifteen insects orders viz., collembola, protura, diplura, lepidoptera, diptera, coleoptera, neuroptera, hymenoptera, hemiptera, orthoptera, ephemeroptera, odonata, embioptera, isoptera and dermaptera were found in the ecosystem of agro-forestry field of IGKV, Raipur. No representative species from the order thysanura, plecoptera, grylloblattodea, phasmida, zoraptera, psocoptera, mallophaga, siphunculata, thysanoptera, mecoptera, trichoptera, siphonaptera and strepsiptera were observed in the present studies.
2. Seasonal activity of various insect pests of Karanja, *P. Pinnata* clearly showed that maximum activity of leaf blotch miner and plant sucking bug was noticed in highest numbers during 1st FN of December, while peak incidence of hairy caterpillar, *Euproctis* sp. was noticed during the 2nd FN of December, while a poor population of leaf hopper with its highest activity was observed during the 1st FN of January.

SUGGESTIONS FOR FUTURE WORK

1. More intensive survey with some more insect trapping methods such as colour traps and sticky traps should be used.
2. Shannon' diversity index should be worked out for various families of different orders.
3. Biodiversity studies of the three different agro-climatic zones of Chhattisgarh state can be taken up.

REFERENCE

- Ahmad, T. 2009. Area estimation under agro-forestry using remote sensing and GIS, Indian agriculture Statistics research institute, New Delhi. pp 28.
- Ahn, S.J. and Park, C.G. 2012. Terrestrial insect fauna of the Junam wetlands area in Korea. Korean Journal of Applied Entomology. 51(2): 111-129.
- Baker, S.C. and Barmuta, L.A. 2006. Evaluating spatial autocorrelation and depletion in pitfall-trap studies of environmental gradients. Journal-of-Insect-Conservation. 10(3): 269-276.
- Barros, R., Degrande, P.E., Ribeiro, J.F., Rodrigues, A.L.L., Nogueira, R.F. and Fernandes, M.G. 2006. Population fluctuation of beneficial insects associated to cotton pests. Arquivos do Instituto Biologico Sao Paulo. 73(1): 57-64.
- Belder and Den, E. 2000. Plant protection and biodiversity: chances for [insect] pest control in leeks? Dutch. Gewasbescherming, 31(2):33-37.
- Berlese, A. 1905. Apparecchio per raccogliere presto ed in gran numero piccoli Artropodi. Redia, Vol. 2, pp. 85-90.
- Bhagat, R.C. 2011. Aphid pests (Insecta) damaging forest-trees in Jammu, Kashmir and Ladakh Himalayas: an updated annotated checklist and biodiversity, Indian Forester, 137(12):1439-1444.
- Bowden, J. 1982. An analysis of the factors affecting catches of insects in light traps. Bullit. Entomol. Res. 72: 536-556.
- Cameron, P.J., Walker, G.P. and D.J. Allan. 1981. Establishment and dispersal of the introduced parasites *Aphidius eadyi* (Hymenoptera: Aphidiidae) in the North Island of New Zealand and an initial effect on pea aphid. New Zeal. J. Zool. 8:105-112.
- Chagnon, M., Hebert, C. and Pare, D. 1999. Community structures of Collembola in sugar maple forests: relations to humus type and seasonal trends. Pedobiologia, 44, 148-174.
- Chagnon, M., Pare, D., Hebert, C. and Camire, C. 2000. Effects of experimental liming on collembolan communities and soil microbial biomass in a

- southern Quebec sugar maple (*Acer saccharum* Marsh.) stand. *Applied Soil Ecology*. (17)81–90.
- Chandra, K., Gupta, S.K. and Shishodia, M.S. 2007. A checklist of orthoptera of Madhya Pradesh and Chhattisgarh, *Zoos' Print Journal*. 22(5):2683-2687.
- Chavan, S.M. and Saxena, S. 2012. Natural parasitization of Karanj Defoliater, *Glyphodes negatalis* Walker (Lepidoptera: Pyralidae): A newly reported insect pests of karanj in South Gujrat, *Medicinal plant research*. Vol.2, No.4 p.18-20.
- Cheng, L. 1976. *Marine insects*. North Holland Publishers, Amsterdam.
- Chey, V., Holloway, J. and Speight, M. 1997. Diversity of moths in forest plantations in Sabah. *Bull. Ent. Res.*, 87. pp. 371-385.
- Dadmal, S.M. and Khadakkar, S. 2014. Insect faunal diversity collected through light trap at Akola vicinity of Maharashtra with reference to Scarabaeidae of Coleoptera. *Journal of Entomology and Zoology Studies*. 2(3): 44-48.
- Deleporte, S. and Tillier, P. 1998. Long-term effects of mineral amendments on soil fauna and humus in an acid beech forest floor. *Forest Ecology and Management*. 118 245-252.
- Dobbs, T.T. and Brambila, J. 2004. *Paragonatas divergens* (Hemiptera: Rhyparochromidae): first confirmed record for Florida and the United States. *Florida-Entomologist*. 87(4): 591-592.
- Eggleton, P., Bignell, D., Sands, W., Waite, B., Wood, T. and Lawton, J. 1995. The species richness of termites (Isoptera) under differing levels of forest disturbance in the Mbalmayo forest reserve, southern Cameroon. *J. Trop. Ecol.*, 11. pp. 85-98.
- Eggleton, P., Bignell, D., Sands, W., Mawdsley, N., Lawton, J., Wood, T. and Bignell, N. 1996. The diversity, abundance and biomass of termites under differing levels of disturbance in Mbalmayo forest reserve, southern Cameroon. *Philos. Trans. R. Soc. London, Ser. B Biol. Sci.*, 351. pp. 51-68.
- Hamer, K., Hill, J., Lace, L. and Langan, A. 1997. Ecological and biogeographic effects of forest disturbance on tropical butterflies of Sumba. *Indonesian J. Biogeogr.*, 24. pp. 67-75.

- Harinath, P., Kumar, V.P. and Ramana, S.P. 2011. The Ecobiology of the common banded awl *Hasora Chromus* Cramer (Lepidoptera: Rhopalocera; Satyridae) from Southern Andhra Pradesh ,Bulletin of Pure and Applied Sciences.Vol.31 A, issue (No.1),2012:p.37-42.
- Harinkhere, R., Ganguli, J. L., Ganguli, R. N. and Shrivastava, S. K. 2013. Survey on status of major agro-forestry tree species and their insect pest scenario in Chhattisgarh plains. Indian J. Trop. Biodiv. 21(1&2) : 105-108.
- Harper, J.L. and Hawksworth, D.L. 1994. Biodiversity: measurement and estimation. Philosophical Transactions of the Royal Society, Series B, London, 345, pp. 5-12.
- Hill, J., Hamer, K., Lace, L. and Banham, W. 1995. Effects of selective logging on tropical forest butterflies on Buru. *Indonesian J. Appl. Ecol.*, 32. pp. 754-760.
- Holloway, J., Kirk-Spriggs, A., Khen, C., Marshall, A. and Swaine, M. 1992. The response of some rain forest insect groups to logging and conversion to plantation. Philos. Trans. R. Soc. London, Ser. B, *Biol. Sci.*, 325. pp. 425-436.
- Hui, D., ZeHua, Z., Song, G., XiangQun, N., Bin, C. 2011. The effect on grassland insects biodiversity of *Metarhizium anisopliae* controlling grasshopper. Journal of Shenyang Agricultural University. 42(1):37-40.
- India State of Forest Report. 2011. Ministry of Environment & Forests Government of India.
- Innis, Donald Q. 1997. Intercropping and the Scientific Basis of Traditional Agriculture. London. Intermediate Technology Publications Ltd.
- Intachat, J., Holloway, J. and Speight, M. 1997. The effects of different forest management practices on geometrid moth populations and their diversity in peninsular Malaysia. J. Trop. Forest Sci., 9. pp. 411-430.
- Islam, K.K., Rahman, G.M.M. and Hoque, A.T.M.R, 2006. Infestation of insect pests in tree-rice agroforestry system. Journal-of-Forestry-Research. 17(1): 44-47.
- Khan, Z.H., Ramamurthy, V.V. 2004. Influence of weather factors on the activity of rice leaf folder, *Cnaphalocrocis medinalis* (Guenee). Annals of Plant Protection Sciences. 12(2): 267-270.

- Laub, C., Youngman, R.R., Love, K. and Mize, T. 2014. Using Pitfall Traps to Monitor Insect Activity. Publications and Educational Resources. Virginia Tech. 444-416p.
- Leakey, R.R.B. 1996. Definition of Agroforestry Revised. *Agro.Today*, 8(1):5-7.
- Leitao, S., P. Pinto, T. Pereira and M.F. Brito. 2007. Spatial and temporal variability of macroinvertebrate communities in two farmed Mediterranean rice fields. *Aquat. Ecol.*, 41: 373-386.
- Liu, J.K. 1999. *Advance hydrobiology*. China Science Press, Beijing, China, pp. 23-120.
- Montagna, M., Lozzia, C.G., Giorgi, A. and Baumgartner, J. 2012. Insect community structure and insect biodiversity conservation in an Alpine wetland subjected to an intermediate diversified management regime. *J. Ecological Engineering*. 47: 242-246.
- Nowinszky, L. 2004. Nocturnal illumination and night flying insects. *Applied Ecology and Environmental Research*. 2(1): 17-52.
- Nummelin, M. and Hanski, H. 1989. Dung beetles of Kibale forest Uganda: comparison between virgin and managed forest. *J. Trop. Biol.*, 5, pp. 349-352.
- Nummelin, M. and Borrowiec, L. 1991. Cassidinae beetles of the Kibale forest Western Uganda: comparison between virgin and managed forests. *Afr. J. Ecol.*, 30, pp. 10-17.
- Nummelin, M. and Fursch, H. 1992. Coccinellids of the Kibale forest Western Uganda a comparison between virgin and managed sites. *Trop. Zool.*, 5, pp. 155-166.
- Oraze, M.J., Grigarik, A.A., Lynch, J.H. and Smith, K.A. 1988. Spider fauna of flooded rice fields in Northern California. *J. Arachnol.* 16:331-337.
- Paoletti, M.G., Dunxiao, H., Marc, P., Ningxing, H., Wenliang, W., Chunru, H., Jiahai, H. and Liewan, C. 1999. Arthropods as bioindicators in agroecosystems of Jiang Han Plain, Qianjiang City, Hubei China. *Crit. Rev. Pl. Sci.*18(3): 457-465.
- Primack, R.B. 1993. *Essentials of conservation biology*. Sinauer Associates, Sunderland, MA, 569p.

- Rocheftorta, S., Therrienb, F., Shetlarc, D. J. and Brodeura, J. 2005. Species diversity and seasonal abundance of Collembola in turfgrass ecosystems of North America. *Pedobiologia*. 50 61-68.
- Sabale, J.P., Das, D. and Samui, R.P. 2010. Influence of weather factors on light trap catches of green leaf hopper at Pattambi, Kerala. *Journal-of-Agrometeorology*. 12(1): 108-110.
- Sahra, G. 2006. Renew checklist of spiders (Aranei) of Iran. *Pakistan-Journal-of-Biological-Sciences*. 9(10): 1839-1851.
- Sahu, C. M. 2014. Studies on various provenances of karanja, *Pongamia pinnata* L. Pierre against major insect pests intercropped with paddy under different Agro-forestry cropping pattern. M.Sc. (Ag.) Thesis. Indira Gandhi Agriculture university, Raipur. 111p.
- Sangwan, S., Rao, D.V. and Sharma, R.A. 2010. A review on *Pongamia pinnata* (L.) Pierre: A Great versatile Leguminous Plant, Biotechnology lab, lab no.5, Department of Botany, University of Rajasthan, Jaipur.
- Santos, S. A. P., Cabanas, J. E. and Pereira, J. A. 2007. Abundance and diversity of soil arthropods in olive grove ecosystem (Portugal): effect of pitfall trap type. *European-Journal-of-Soil-Biology*. 43(2): 77-83.
- Shannon, C.E. and Weaver, W. 1949. The mathematical theory and communication. University of Illinois press, Urbana.
- Smith, J., Potts, S. and Eggleton, P. 2008. Evaluating the efficiency of sampling methods in assessing soil macrofauna communities in arable systems. *European Journal of Soil biology*. 44 271-276.
- Subharani, S., Singh, T. K., Singh, P. M. and Shah, M. A. S. 2007. Biodiversity of hymenopteran parasitoids on certain insect pests of crops in Manipur, Uttar Pradesh *Journal of Zoology*, 27(1):93-100.
- Thakur, A., Singh, N. K. and Singh, J. 2008. Biodiversity of lepidopterous insects in the field crops under Varanasi climatic conditions, *Journal of Applied Zoological Researches*,19(2):127-131.
- Vandermeer, J. 1981. Elementary mathematical ecology. John Wiley and Sons, New York, pp. 294.

- Vrieze, M. de. 2008. Observations to the noctuid fauna of Greece (Lepidoptera: Noctuidae). *Entomologische-Zeitschrift-mit-Insekten-Borse*. 118(3): 119-127.
- Wickramasinghe, L.P., Harris, S., Jones, G. and N.V. Jennings, 2004. Abundance and species richness of nocturnal insects on organic and conventional farms: effects of agricultural intensification on bat foraging. *Cons. Bio.*, 18(5): 1283-1292.
- Woin, N., Takow, J.A. and Kosga, P. 2005. Predatory ground-dwelling beetles (Carabidae and Staphylinidae) in upland rice fields in North Cameroon. *Int. J. Trop. Insect Sci.*, 25(3): 190-197.
- Www.google.com (http://en.wikipedia.org/wiki/Insect_biodiversity).
- Yahiro, K. and Yano, K. 1997. Ground Beetles (Coleoptera, Caraboidea) caught by light trap during ten years. *ESAKIA*, 37: 57-69.

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Signature

SEASONAL INCIDENCE OF INSECT PEST OF KARANJA, *Pongamia pinnata* AT THE AGRO-FORESTRY FIELD OF IGKV, RAIPUR

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ABSTRACT

Chhattisgarh region is one of the richest sources of biodiversity in India, having a wide range of medicinal plants. Karanja, *Pongamia pinnata* is well known for its medicinal properties. The present studies were undertaken during November 2014 to March 2015 to record the insect-pest complex of Karanja plants in Agro-forestry farm, College of Agriculture, IGKV, Raipur. Four insect species viz. leaf blotch miner, gundhi bug, hairy caterpillar, *Euproctis* sp. and leaf hopper, belonging to two orders were observed to be associated with Karanja plant. Out of these, leaf blotch miner occurred throughout the season with highest and lowest infestation of 18.28 and 4.83 blotches/plant respectively. Highest population of Gandhi bug was observed during first fortnight of December with 0.22 insects/plant. The peak activity of hairy caterpillar and leaf hopper was occurred during second fortnight of December with mean population of 0.17 larvae/plant and 1.61 hoppers/plant respectively.

Key words- Agro-forestry, Karanja, *Pongamia pinnata*, Seasonal incidence

INTRODUCTION

Karanja, *Pongamia pinnata* belongs to the family Fabaceae (Papilionaceae). It is a medium sized evergreen tree with a spreading crown and a short bole. The seeds are largely exploited for extraction of a non edible oil commercially known in India as 'Karanja oil' which is well known for its medicinal properties. All parts of the plant have been used as crude drug for the treatment of tumors, piles, skin diseases, wounds and ulcers (Tanaka *et al.*, 1992).

Historically, this plant has long been used as a source of traditional medicines, animal fodder, green manure, timber, fish poison, fuel and also used as source of biodiesel. *P. pinnata* has an added advantage of nitrogen fixing ability and drought resistance due to its nodulation properties (Sangwan *et al.*, 2010). Other uses are incorporation of leaves and the press cake into soils which improves fertility. Dried leaves are used as an insect repellent in stored grains. The press cake, when applied to the soil, has value as a pesticide, particularly against nematodes (Anon., 1986; Orwa *et al.*, 2009). *P. pinnata* seeds contain about 40% oil, which can be converted to biodiesel by transesterification method (Meher *et al.*, 2006).

Among the various factors causing a negative impact on the vigour, growth and yield of the plant, insect pests are a major constrain. Sahu, 2014 reported (leaf webber, leaf blotch miner, leaf hopper, leaf gall maker, bark borer, leaf defoliator, beetle, green bug, gundhi bug, thrips, leaf folder, mealy bug, cow bug, hairy caterpillar, hawk moth and red cotton bug) on karanja from the agro forestry field, IGKV, Raipur. The activity of the above mentioned insects varies from time to time and very scarce information is available regarding the incidence of major and minor insect pests. Hence, the current experiment was taken up to study the seasonal incidence of various insect pests of karanja and their peak activity period on the basis of which management strategies can be formulated in future.

MATERIALS AND METHODS

The present studies were conducted from 'November 2014 to March 2015' at the Agro-forestry farm, College of Agriculture, IGKV, Raipur on the provenance Jabalpur of karanja, *Pongamia pinnata*. Observation was recorded on the provenance Jabalpur at fort nightly interval on the various species of insects and their numbers on 6 trees randomly selected. From each tree 3 branches were tagged for recording observations.

RESULTS AND DISCUSSION

In the present studies, four insect pests were observed, namely the leaf blotch miner, gundhi bug, hairy caterpillar, *Euproctis* sp. and leaf hopper,

Leaf blotch miner

Blotch miner is a very serious and common pest of karanja, *P. pinnata*. The larvae makes circular blotches on the upper (dorsal) surface of the leaves. On an average 4-17 blotches were observed per 3 leaves and sized on an average about 8-20 mm in length and 4-12 mm in width and there was only a single larvae/blotch. Severe infestations led to reduction in the photosynthetic area of the leaves thus reducing growth and vigour of the plants. The full grown larvae was slender, minute, orangish-yellow with large black head measuring about 4-6 mm in length. The peak activity of blotch miner was noticed during the 2nd fort night of December with an average population of 18.28 blotches/plant; and lowest 4.83 blotches/plant during 1st fort night of February. The population again showed a rising trend in the 2nd fort nightly of February after which it declined in the following months. (Table:1)

Gundhi bug

Both nymphs and adults sucked the sap of young leaves. Body of the bugs was green in color with brown colored wing. Adult bug measured about 12.0 to 15.0 mm in

length and 3.0-4.0 mm in width. It was also observed that the bugs secreted a green colored liquid having a strong offensive odor. The activity of this insect was noticed from the 2nd fort night of November with a mean population of 0.17 adults & nymphs/plant and increased to a maximum of 0.22 adults & nymphs/plant in the 1st fort night of December, which later decreased with no population at all in the following months from January to March. (Table:2)

Hairy caterpillar, *Euproctis* sp.

Hairy caterpillar, *Euproctis* sp. was noticed although a very low population was seen. Early instar larvae of hairy caterpillar, *Euproctis* sp. fed on the green part of the leaves and skeletonized them but later instar larvae completely ate the leaves along with soft apical shoots of plants. The activity of *Euproctis* sp. was seen from the 2nd fort night of November with a population of 0.11 larvae/plant and rose to 0.17 larvae/plant in the 2nd fort night of December. No population of *Euproctis* sp. was observed in the following months up to march. (Table:3)

Leaf hopper

Leaf hopper was one of the major sucking pests of

karanja, *P. Pinnata*. Both nymphs and adults were found sucking the young leaves and shoots of the plants. They also secreted 'honey dew' on which sooty mould was seen as black patches, due to which plants appeared sickly and vigour was affected. Adult leaf hopper of karanja measured about 4-5 mm long with light green to dark green with black colored eyes and two black spots on the dorsal side of the prothorax. The population of leaf hopper started building up from the 1st fort night of December with 1.22 adults & nymphs/plant and increasing up to 1.61 adults & nymphs/plant in the forth coming fort nights of January, particularly in the 1st fort night, and thereby decreasing to 0.89 adults & nymphs/plant in the 2nd fort night of January and with nil population during February and March. (Table:4)



Table 1: Seasonal incidence of Leaf blotch miner of Karanja, *Pongamia pinnata*:

No. of plants	Mean observations										Pooled Mean
	12Nov	27Nov	12Dec	27Dec	11Jan	26Jan	10Feb	25Feb	12Mar	27Mar	
P1	9.33	10.33	15.33	16.33	10.00	8.33	6.67	9.67	5.33	4.33	9.57
P2	31.00	27.00	25.67	23.00	13.00	8.33	7.33	9.00	9.00	7.00	16.03
P3	15.00	14.67	14.33	11.67	7.67	5.00	4.00	4.00	5.00	3.67	8.50
P4	17.67	17.67	21.33	17.67	13.00	8.00	3.00	6.00	4.67	4.00	11.30
P5	14.67	13.67	13.33	13.33	8.33	7.00	3.33	5.67	7.67	5.67	9.27
P6	14.33	19.67	19.67	21.00	17.33	14.33	4.67	13.33	7.00	6.33	13.77
Pooled Mean	17.00	17.17	18.28	17.17	11.56	8.50	4.83	7.94	6.44	5.17	

Table 2: Seasonal incidence of Gundhi bug of Karanja, *Pongamia pinnata*:

No. of plants	Mean observations										Pooled Mean
	12Nov	27Nov	12Dec	27Dec	11Jan	26Jan	10Feb	25Feb	12Mar	27Mar	
P1	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
P2	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.03
P3	0.00	0.00	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
P4	0.00	0.33	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.07
P5	0.00	0.33	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
P6	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Pooled Mean	0.00	0.17	0.22	0.11	0.00	0.00	0.00	0.00	0.00	0.00	

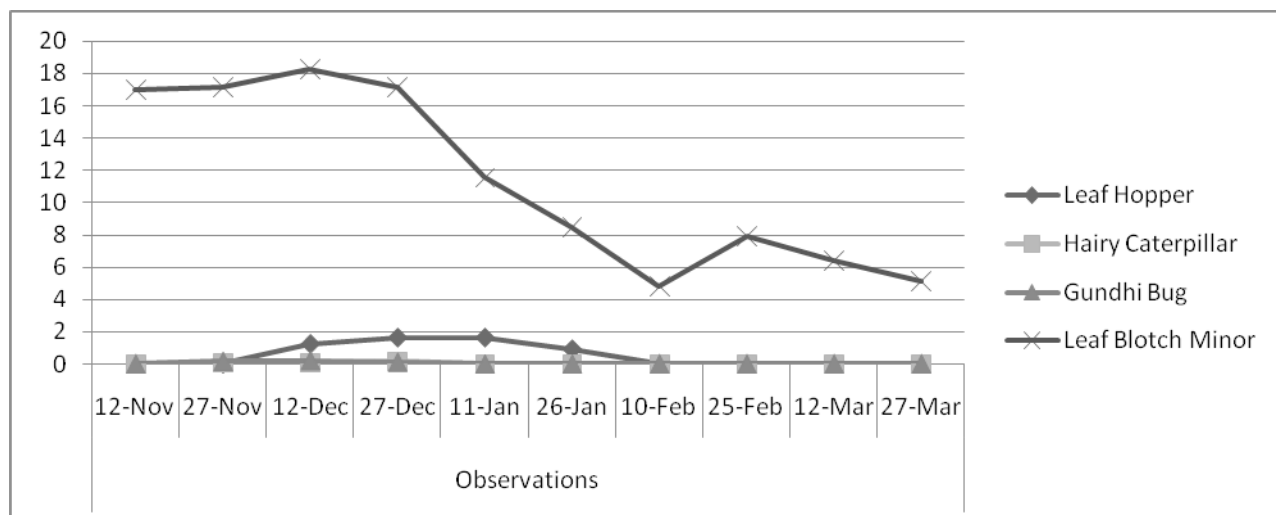
Table 3: Seasonal incidence of Hairy caterpillar of Karanja, *Pongamia pinnata*:

No. of plants	Mean observations										Pooled Mean
	12Nov	27Nov	12Dec	27Dec	11Jan	26Jan	10Feb	25Feb	12Mar	27Mar	
P1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P3	0.00	0.67	0.67	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.20
P4	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.03
P5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pooled Mean	0.00	0.11	0.11	0.17	0.00	0.00	0.00	0.00	0.00	0.00	

Table 4: Seasonal incidence of Leaf hopper of Karanja, *Pongamia pinnata*:

No. of plants	Mean observations										Pooled Mean
	12Nov	27Nov	12Dec	27Dec	11Jan	26Jan	10Feb	25Feb	12Mar	27Mar	
P1	0.00	0.00	0.00	0.00	3.33	0.00	0.00	0.00	0.00	0.00	0.33
P2	0.00	0.00	3.33	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.73
P3	0.00	0.00	2.33	4.33	1.00	0.00	0.00	0.00	0.00	0.00	0.77
P4	0.00	0.00	0.00	0.00	5.33	0.00	0.00	0.00	0.00	0.00	0.53
P5	0.00	0.00	0.67	0.33	0.00	5.33	0.00	0.00	0.00	0.00	0.63
P6	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20
Pooled Mean	0.00	0.00	1.22	1.61	1.61	0.89	0.00	0.00	0.00	0.00	

Graph 1: Seasonal incidence of insect pest of Karanja, *Pongamia pinnata*:



REFERENCES

- Anonymous (1986) The useful plants of India. Publications and Information Directorate, CSIR, New Delhi, India.
- Meher, L. C., Vidya, S. D. and Naik, S. N. (2006) Optimization of Alkali-catalyzed transesterification of *Pongamiapinnata* oil for production of biodiesel. *Bioresource Technology* **97**: 1392-1397.
- Orwa, C., Mutua, A., Kindt, R., Jamnadass, R. and Simons, A. (2009) *Agroforestry Database: a tree reference and selection guide version 4.0*.
- Sahu, C. M. (2014) Studies on various provenances of karanja, *Pongamiapinnata* L. Pierre against major insect pests intercropped with paddy under different Agro-forestry cropping pattern. M.Sc. (Ag.) Thesis. Indira Gandhi Agriculture university, Raipur. 111p.
- Sandarbh Chhattisgarh (2002) Deshbandhu Publishers Raipur, pp 74-75.
- Sangwan, S., Rao, D. V. and Sharma, R.A. (2010) A review on *Pongamiapinnata*(L.) Pierre: A Great versatile Leguminous Plant, Biotechnology lab, lab no.5, Department of Botany, University of Rajasthan, Jaipur.
- Tanaka, T., Iinuma, M., Fujii, Y., Yuki, K. and Mizuno, M. (1992) Flavonoids in root bark of *Pongamiapinnata*. *Phytochemistry* **31**: 993-998.