“INSECT PEST ASSOCIATION IN *DALBERGIA SISSOO,* PADDY BASED AGRISILVICULTURE SYSTEM”

THESIS

Submitted to the

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MASTER OF SCIENCE

In

FORESTRY

(PLANTATION TECHNOLOGY)

By

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CERTIFICATE- I

This is to certify that the thesis entitled "Insect Pest association in *Dalbergia sissoo,* Paddy based Agrisilviculture system" submitted in partial fulfillment of the requirement for degree of **MASTER OF SCIENCE** in **FORESTRY (AGRO-FORESTRY)** of the Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur is a record of bonafide research carried out by Shri Chandan Manjhi, I.D. No. AF/JB/814/2007 under my supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director of Instruction.

No part of the thesis has been submitted for any other degree or diploma (Certificate awarded etc.). All the assistance and help received during the course of the investigation has been acknowledged by him.

Dr. R. Bajpai
Chairman of the Advisory Committee

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CERTIFICATE-II

This is to certify that the thesis entitled "Insect Pest association in *Dalbergia sissoo,* Paddy based Agrisilviculture system" submitted by **Shri Chandan Manjhi** to the Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE IN FORESTRY (AGRO-FORESTRY)** in the **Department of Forestry,** has been, after evaluation, approved by the External Examiner and by the Student's Advisory Committee after an oral examination of the same.

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LIST OF TABLES

Table No.	Title	Page No.
3.1	Weekly average of meteorological data during the crop season (June to November 2012)	11
3.2	Physical and Chemical properties of the soil of experimental field	13
3.3	Previous history of the experimental field	13
3.4	Skeleton for analysis of variance (ANOVA)	17
4.1	Succession of insect pest complex of *Dalbergiasissoo* and paddy during 2012	20
4.2	Seasonal incidence and population dynamic of Rice leaf folder	24
4.3	Correlation matrix of weather parameters withRice leaf folder during (2012)	25
4.4	Seasonal incidence and population dynamic of Brown Plant Hopper	27
4.5	Correlation matrix of weather parameters withbrown plant hopper during (2012)	28
4.6	Seasonal incidence and population dynamic of *Green Leaf Hopper*	30
4.7	Correlation matrix of weather parameters withGreen Leaf hopper during (2012)	31
4.8	Seasonal incidence and population dynamic of Gundhi Bug	33
4.9	Correlation matrix of weather parameters withGundhi bug during (2012)	34
4.10	Seasonal incidence and population dynamic of Plecopterareflexa	36

4.11	Correlation matrix of weather parameters with*Plecopterareflexa* during (2012)	37

LIST OF FIGURES

Figure No.	**Title**	**Page No.** (In Between)
1	Weekly average of meteorological data during the crop season (June to November 2012)	11-12
2	Layout plan of experiment field	14-15
3	Seasonal incidence and population dynamic of Rice leaf folder	24-25
4	Seasonal incidence and population dynamic of Brown Plant Hopper	27-28
5	Seasonal incidence and population dynamic of *Green Leaf Hopper*	30-31
6	Seasonal incidence and population dynamic of Gundhi Bug	33-34
7	Seasonal incidence and population dynamic of Plecopterareflexa	36-37
8	Seasonal incidence and population dynamics of insect pest of *Dalbergiasissoo*and paddy	37-38

LIST OF FI

Figure No.	Title	Page No. (In Between)
1	Weekly average of meteorological data during the crop season (June to November 2012)	11-12
2	Layout plan of experiment field	14-15
3	Seasonal incidence and population dynamic of Rice leaf folder	24-25
4	Seasonal incidence and population dynamic of Brown Plant Hopper	27-28
5	Seasonal incidence and population dynamic of *Green Leaf Hopper*	30-31
6	Seasonal incidence and population dynamic of Gundhi Bug	33-34
7	Seasonal incidence and population dynamic of Plecopterareflexa	36-37
8	Seasonal incidence and population dynamics of insect pest of *Dalbergiasissoo*and paddy	37-38

INTRODUCTION

The genus *Dalbergia* includes over hundred species of trees, shrubs and woody climbers distributed throughout the tropical and sub-tropical regions of the world. Of these, 27 species of the genus are represented in India, among them 15 species are indigenous and 3 species are endemic. *Dalbergia sissoo* Roxb. (Fabaceae) is one of the most important commercially valuable timber species. It is best known for its highly valued timber that has wide use as construction timber, boats, cart wheels, veneer plywood, bent wood, high quality furniture, cabinets, flooring and turnery works. In addition to its outstanding timber quality and high commercial value, the tree commonly provides high quality fuelwood and charcoal, fodder, green manure, nitrogen fixation and other traditional medicines. It is a large deciduous fast growing tree which can grow up to 30 meter height and 90 centimeter diameter at breast height at maturity. This tree species commonly occurs from sea level up to 1000 meter and prefers riverine environment. It grows well on rich alluvial soil, pure sand or gravel conditions with plentiful moisture and good drainage.

Dalbergia sissoo has a rich complex of insect fauna of about 125 species however, only 10 species are known to have attained economic status as potential pests of nursery and plantations. Insects and pests belonging to 9 families of Lepidoptera, 10 of Coleoptera, 5 of Hemiptera, 1 of Orthoptera, and one of Diptera have been assessed in stand of *Dalbergia sissoo*. Among them *Plecoptera reflexa* (Lepidoptera: Noctuidae) and *Apoderus sissoo* (Coleoptera: Curculionidae) are most common and destructive. Defoliating insect- several leaf-eating caterpillars have been recorded on living *Dalbergia sissoo* trees in India and Pakistan. They are *Ascotis selenaria imparata, Enarmonia jaculatrix, Phytometra orichalcea, Plecoptera reflexa* and *Anomala dalbergiae. Plecoptera reflexa* is the most harmful, causing complete defoliation. Trees stripped of their leaves remain leafless for the greater part of the growing season. Boring insects- several insects attack the bark and stems of unhealthy or dying trees. These include *Cladobrostis melitricha, Sinoxylon anale, Sinoxylon capillatum* and *Sinoxylon*

sudanicum. Perissus dalbergiae and *Sinoxylon anale* attack the trunk and branches of living trees. Sap-sucking insects- several sap-sucking insects are reported in India and Pakistan. These include *Aleurolobus marlatti, Aleurotrachelus rachipora, Aschistocoris sulcatus, Aspidiotus orientalis, Dialeurodes decempunctata, Drosicha dalbergiae, Gargara mixta,* Homoecerus sp. *Pulvinaria maxima* and *Walkeriana cinerea*. Termites of the Isoptera genera are also common pests of *Dalbergia sissoo* throughout its range.

Paddy - It is grown in over 70 % of the area in Asia and it forms a staple food for about 2.8 billion people. About 1400 insects covering 100 species are reported is the world to feed on this crop, of which about 20 species are of Economic significance in different parts of the country. In Madhya Pradesh about 10-12 pests are important causing significant damage. These are Yellow stem borer, Brown Plant hopper, Brown Plant hopper, Rice leaf folder, Earhead bug, Green leaf hoppers, Caseworm, Gall fly, Paddy skipper, Horned caterpillar, and Thrips etc.

Dalbergia sissoo extensively used in agroforestry systems. The species is popular with farmers because it provides multiple products for subsistence plus high-quality timber for local markets. At the same time, it enriches the soil through the incorporation of green manure. It also serves as a windbreak for orchards and a shade tree for light sensitive crops. These multiple uses make *Dalbergia sissoo* a good choice for a wide range of agroforestry systems.

Trees with crops- In agroforestry systems with crops, *Dalbergia sissoo* is planted along field boundaries, in rows or as scattered individual trees. The establishment of scattered trees on cropland is traditional in many areas where the species is indigenous. Farmers may plant seedlings or simply encourage natural regeneration. At a wide spacing, these individual trees have little negative impact on crop production, even at maturity. Trees may be planted in single rows on boundaries along one or more sides of a field. The normal spacing is 2 to 4 m.

Crop growth and yields continue to decline each year as the trees become larger. The effect can be reduced by planting trees at wider spacing of 3 to 4 m. Planting trees in a north-south direction also minimizes competition for sunlight. *Dalbergia sissoo* is often planted in windbreaks to protect fruit orchards. Spacing between trees varies from 1 to 3 m depending on wind velocity and other site conditions. This species is also used as a shade tree for coffee, tea, cocoa, cardamom, ginger and turmeric production. In these systems, tree spacing varies from 5 x 5 to 12 x 12 m depending on site characteristics and management objectives. Such shade-loving crops also benefit from the trees positive contributions to soil fertility. *Dalbergia sissoo* may be planted as one component of multitiered home-garden systems. The trees contribute fodder, fuelwood, green manure, timber, shade and soil improvement.

The present work is an attempt to cover and compile the scattered information at one place so as to provide detailed knowledge on various insect pest species, their identification, nature of damage and period of infestation.

Keeping above fact in view the present investigation entitled “Insect Pest association in *Dalbergia sissoo,* Paddy based Agrisilviculture system” has been proposed with following objectives:-

- Identification / period of infestation of major and minor pest of *Dalbergia sissoo* and Paddy*.*
- Effect of insect pest on different pruning 0%, 25%, 50%, and 75% of *Dalbergia sissoo*.
- Population dynamics of insect pest of *Dalbergia sissoo* and correlation studies with weather parameters.

REVIEW OF LITERTURE

The literature available on *Dalbergia sissoo* and paddy insect pest complex on various aspects is vast and voluminous, precisely in case of *Plecoptera reflexa,* rice leaf folder etc. But keeping in mind the research work, "Insect Pest association in *Dalbergia sissoo,* Paddy based Agrisilviculture system" the review of literature related to the topic which has direct or indirect relation with the present investigations are cited below:

Beeson, (1941) recorded several leaf-eating caterpillars on *Dalbergia sissoo*. They are *Ascotis selenaria imparata*, *Enarmonia jaculatrix, Phytometra Orichalcea*, *Plecoptera reflexa,* and *Anomala dalbergiae. Plecoptera reflexa* is the most harmful, causing complete defoliation. Trees stripped of their leaves remain leafless for the greater part of the growing season.

Beeson, (1941) observed leaf-eating beetles on *Dalbergia sissoo* in India and Pakistan. *Adoretus caliginosus* makes holes in the leaves between principle nerves. *Amblyrrhinus poricollis* damages foliage and *Halyzia sancrite* damages the surface of leaves. Others beetles are *Gynandropthalma quadripunctata, Illeis cincata, Mimastra cynura* and *Myllocerus pustulatus*.

Beeson, and Bhatia (1941) record the wood borers *Agrilus dabergia, Lyctus africanus* and *Stromatium barbatum* in India. The wood tunneling insect *Sinoxylon crassum* has also been reported.

Beeson, (1941) observed *Caryedon gonagra* (*Synpanchymerus gonagra*): a widely distributed seed pest of Acacia *nilotica.* This species is referred to be a most noxious pest of many leguminous tree seed such as, *A. tartolis, A. Senegal*, *Albizia lebbeck*, *Cassia accriculato*, *C. fistula*, *P. Juliflora, P. Cineraria* and *Tamarindus indica*.

Browne, (1968) listed largest known Coccoidea (*Hemaspidoproctus cinereo*). This species feed on the sap of many tree species. The important record hosts include *Acacia nilotica* sub spp. indica *Anoportant latifolia*, *Delbergia sissoo*, *Santalum album* and *Terminalia spp*.

Brown, (1968) reported *Apoderus sissu* a leaf-rolling beetle from northern India and Pakistan. This harmful insect completely destroys flushes of new leaves in plantations and nurseries. To dislodge the insects from seedlings in nurseries, a rope is dragged across rows of plants or individual seedlings are shaken. Dislodged insects should be swept into a pile and destroyed.

Brown, (1968) carried out study and observed adult beetle (*Diapromorpha balteata*) that feed on the foliage, and was recorded as minor pest.

Brown, (1968) several insects attack the bark and stems of unhealthy or dying trees. These include *Cladobrostis melitricha*, *Sinoxylon anale*, *Sinoxylon capillatum* and *Sinoxylon sudanicum. Perissus dalbergiae* and *Sinoxylon anale* attack the trunk and branches of living trees. The first of these can be controlled by early disposal of infected material.

Mathurig, (1971) discussed the importance of Bruchids; as an important factor in the regeneration of leguminous tree including *Acacia* in the arid and semi-arid zones of Africa and North America.

Lobeyrie, (1981) reported that the larvae of *Brachidae* are seed consumer which form it one of the very rare families colonizing the ripe seed of legumes. The sub family Bruchidae is known for the damaged caused on seed of leguminous plant.

Singh, (1986) recorded considerable damage to *A. Nilotica*, *Delbergia sissoo* and *Prosopis cineraria* which varied with soil type. This presumably influenced the physiological status of the tree in relation to the pests.

Sen- Sharma, (1987) studied debilitating impact of insects on forage quality and quantity or on seed production. Its effect may be so great that remedial activities are desirable.

Sen- Sharma, (1987) summarized the data available on known pests of several important forage tree legumes and provided additional information, about various pests infesting forage crops.

Haukioja, (1991) gave information of possible relevance to the cultivation of tree legumes, The phenomenon of " induced resistant" this arise when herbivore induced chemical changes in the plant, which may cause negative feedback on insect of the same species, and some time even on the other species. The effect is so strong that it may influence population of insects.

Walter, (1994) provided information of possible relevance to the cultivation of the tree legumes. The phenomenon of "induced resistant" this induced chemical changes in the plant, which may cause negative feedback on insect of the same species and at the same time even on the other species. The effect is so strong that it may influence population number of insect.

Walter, (1994) dealing with specific examples of insect pests, adoption and ecology must be considered in each species presents as with its own challenge which may vary with changing environmental condition from area to area and from time to time.

EI-Atta and Abdel Nour (1995) recorded *Anacridiam melanorhodan* is the larger grass hopper that rows in savannahs and wooded steppes of northern central & west Africa and the near east .It feeds on leaves and the young green parts of plant and broad host range. It is serious pest of planted and natural pest of Sudan.

Hunt *et al.,* (1996) recorded competition and relative abundances of foliage feeding adult beetle (*Chrysomelidae*) also known as 'Leaf Beetle' was monitored in a plantation of juvenile black wattle, *Acacia mearnsii* de wild, from spring 1992 until late February 1993. The insect assembled were chlorinated by leaf beetle (coleptera, chry somedidae) which belonged to 4 subfamilies (Chrysomelinae, Cryptocephelinae, Gacerucinae and Eumolpinae) and 21 species, two species, *Calomela Perriss* leaf (Chrysomelinae) and *Monolepta ordinaria* Balckburn (Galeruvinae) each contributed about 25% of the total Chrysomelid abundance for the study period with *M. ordinaria* most abundant in November and December 1992 and *C. Parilus* most common in January and February 1993. Adult bettles of 26 Chrysomelid species were recorded on bipinnate Wattle in nearby open forest, including all species recorded in the plantation.

Rawat and Singh, (2003) observed the intensity of attack in 2002 was so severe that the tree canopies had completely been defoliated as early as the second week of April. Canopy damage to this extent has not been noticed in the month of April in previous year.

Dhakal and Kjaer, (2005) conducted an experiment in which they analyzed seedling seed orchard (SSO) that was heavily infested by *Aristobia horridula* a beetle that has become a sever pest infesting and killing young trees in *Dalbergia sissoo* plantings. Large and highly significant differences were found between families in mortality, showing that some progenies seem to resist the attack much better than others.

Ali, *et. Al.,* (2006) conducted study on the seasonal population fluctuation of sissii tree hopper, *Gargara mixta* (Membracidae : Homoptera) conducted in different growth stage of *Dalbergia sissoo* plantation at Pusa Farm of Rajendra Agriculture University, Pusa (Bihar) in 1993. The seasonal population of *Gargara mixta* per leaf per stem and per branch of *Dalbergia sissoo* sapling varied from 0.59 to 4.08, 0.58 to 5.57 and 0.68 to 9.80 during morning and evening respectively. The maximum temperature showed significant and possitive correlation with the population of *Gargara mixta.* Relative humidity has no significant effect.

Kiruba *et. al*., (2006) studied the pests of paddy crop and coconut plantation and their management through traditional methods by indigenous people of Kanyakumari district, Tamil Nadu. A total of 10 insect pests and 2 non-insect pests were identified in paddy fields.

Ali, *et. al.,* (2007) conducted a systematic study on the seasonal sequence of occurrence, incidence and maximum occurrrence of *Dalbergia sissoo* leaf blinder, *Dichomeris eridantis* Mey. In 1993. It revealed that moderate to maximum occurrence of the pest was recorded from February to October. Periodic incidence of the pest ranged from 0.30 to 10.80 in different growth maximum in the week of june 1993. The maximum temperature showed significant and positive correlation (r=0.912) with the population. Relative humidity had no significant effect.

Yang Lin-nan *et. al.,* (2008) recorded Paddy stem borer (*Scirpophaga incertulas*) is an important insect pest of rice. Damaged plants wither and the tassels die or become blanched and infertile. Severe infestation leads to greatly decreased grain production. Best control of damage requires accurate describing and forecasting of the population dynamics.

Deka and Barthakur, (2010) observed damage Yellow stem borer (*Scirpophaga incertulas*), a monophagous pest of paddy and considered as most important pest of rain fed low land and flood prone rice eco-systems.

Pawan, (2012) recorded the incidence of insect-pests and diseases of paddy during 1999 to 2009 in major rice growing districts of H.P. During their studies over last ten years, it was observed that the insects and diseases (whorl maggot, chaffer beetle, bacterial leaf blight), which were not prevalent in rice growing areas of H.P. are the major pests. Hoppers, which were not causing any damage to rice crop in the state, become very severe in 2007 in Rait block of district.

Prashant *et. al.,* (2012) observed the seasonal incidence of brown plant hopper (BPH) showed its presence from July 2009 to January 2010. Occurrence of BPH on bunds during rice cropping season (August 2009-January 2010).

Selvaraj *et. al.,* (2012) determined the multiple-pest economic injury levels (EILs) on Pusa Basmati 1 rice (Oryza sativa L.) at different crop growth stages through field and pot experiments in 2009 and 2010. The yield loss to damage functions were derived for two-pest combinations of leaf folder, Cnaphalocrocis medinalis Guenée, and stem borers, Scirpophaga incertulas (Walker) and Sesamia inferens (Walker), at reproductive crop stage during 2009 and for leaf folder and planthoppers, Nilaparvata lugens (Stål.) and Sogatella furcifera Horvath, at vegetative crop stage, and planthoppers and stem borers at reproductive stage.

Arya and Chander, (2012) observed the paddy crop was to be more prone to leaf folder attack during pre-flowering phase than post-flowering.

Rajna and Chander, (2012) studied the spatial distribution of rice planthoppers, Nilaparvata lugens (Stal) and Sogatella furcifera (Horvath)

together, rice leaf folder Cnaphalocrocis medinalis (Guenee) and their predators was studied during kharif, 2010, using standard normal variable (d), discrete frequency distributions viz., Poisson, binomial and negative binomial, and regression models viz., Taylor's power law and Iwao's mean crowding regression. Planthoppers had aggregation as dominant type of distribution pattern, while leaf folder followed random distribution during most of crop growth stages.

MATERIALS AND METHODS

The details of material used and the methods adopted during the course of investigation entitled**"Insect Pest association in *Dalbergia sissoo*, Paddy based Agrisilviculture system."** are described in this chapter.

3.1 Experiment site

The field experiment was conducted at Dusty Acres Research Farm, Department of Forestry, Jawaharlal Nehru KrishiVishwaVidyalaya, Jabalpur during Kharif season of 2012..

3.2 Climate and weather conditions

Jabalpur lies between 22°49' to $24^0$8' North Latitude and $78^0$21' to $80^0$58' East Longitudewith an altitude of 411.78 meters above the mean sea level. The climate of the locality is characterized as typically semi-humid and tropical, with is featured by hot dry summer and cool dry winter. It is classified as" Kymore Plateau and Satpura Hills" agro-climate zone, as per norm of National Agricultural Research Project and is broadly known as rice-wheat crop zone of Madhya Pradesh. As per recent classification of National Bureau of Soil Survey and Land use planning (NBSSLUP), Nagpur, this area belongs to agro-ecological region number 10, named as Central High Lands (Malwa and Bundelkhand), sub-region number 10.1, named as hot sub-humid (dry) eco-region (Malwa Plateau, VindhayanScarpland and Narmada Valley).

The mean annual rainfall of Jabalpur, based on last 20 years data 1350 mm which is mostly received from south-west monsoon between mid June to end of September with little occasional rainfall of 67.9 mm during other months. The mean monthly minimum temperature varies between 5.3 to 6.1°C in December and January, and maximum temperature varies between 40.2 to 40°C during May and June, respectively January is the coldest month of the year with minimum temperature being 5°C. Generally relative humidity remains very low during summer (20 to 23%); moderate (60 to 75%) during winter and it attains high value (80 to 95%) during rainy season.

Table 3.1:Weekly meteorological parameters during the crop season (June to November 2013)

Month	Meteo. week	Temperature max. (C)	Temp. min.	Relative humidity (%)Morning	Relative humidity (%)Evening	Sunshine hrs	Rainfall (mm)	No of Rainy days	Wind vel. (Km/hr)
June	24	40.2	26.7	64	30	4.9	58.2	2	8.4
	25	33.2	23.2	78	53	3.3	63.4	2	11.3
	26	37.7	27	64	42	6.4	0	0	9.5
July	27	34.5	24.4	85	62	5.6	296.8	3	5.7
	28	31.3	23.9	88	77	4.7	106	4	6.2
	29	32.3	24.1	90	76	3.1	117.5	3	7.3
	30	28.2	22.8	95	88	3	119.9	5	6.3
	31	26.3	22	94	87	0	32.4	4	5.3
Aug.	32	27.7	22.7	96	88	1.2	145.8	5	6.7
	33	28.2	23	89	81	0.8	101.8	5	6.4
	34	30.2	22.9	92	77	4.9	84.4	4	3.2
	35	31.9	24.2	92	69	4.8	3	0	4.5
Sept.	36	30.8	23.9	93	89	2.8	52.2	3	5.3
	37	30.7	23.4	91	89	2.8	87.4	2	5.1
	38	30.8	23.9	89	69	4.6	11	1	5.7
	39	31.9	22.6	88	51	8.7	0	0	5.1
Oct.	40	33.4	21.9	91	44	7.3	2.3	0	3.1
	41	32.4	18.5	83	35	9	0	0	2.3
	42	32.5	18.6	79	32	9.4	0	0	2.5
	43	31.6	15.2	82	35	8.4	0	0	2.5
Nov.	44	27.9	15.6	91	51	6.7	0	0	2.4
	45	28.2	14.6	88	30	7.7	0	0	2.5
	46	28.6	10	85	28	8.4	0	0	2.4
	47	27.9	10.6	88	29	7.6	0	0	2.3
	48	28.4	11.5	83	33	8.4	0	0	2.2
						Total	**1282.1**	**43**	

3.3 Weather conditions during crop season

Seasonal variations prevailing during the growth period play an important role not only in the growth and development of the crop which ultimately influence the final yield of crop. The weekly meteorological data during the course of investigation recorded during crop season at Meteorological observatory, College of Agricultural Engineering, JNKVV, Jabalpur are presented in Table 3.1 and graphically illustrated in Figure-1.

It is evident from the data that weather conditions were almost favourable for the growth and development of paddy. The monsoon commenced in the second week of June and terminated in the third week of October. During the growing season of crop (June to Nov. 2012) Maximum temperature40.2 was recorded in June and minimum temperature 10.6°C in Nov, relative humidity ranged between 41.to 96 % in morning and 29 to 89% in evening. The total rainfall received during the crop season was 1282.1.mm, which was obtained in 43rainy days. The wind velocity varied between 2.2 to 11.3. km per hours. The mean sunshine hour ranged between 0 to 8.7 hours per day.

3.4 Soil

In order to find out the Physico-chemical properties of soil of the experimental field, soil samples were taken randomly from different spots at 0 to 30 cm with the help of screw anger before sowing of the experiment. The soil samples were well mixed together for making representative samples. The composite samples were analyzed for physico-chemical properties of the soil in the laboratory, Department of soil science and Agricultural Chemistry as per standard methods. The analytical values of soil were presented in Table 3.2.

Table 3.2: Physical and Chemical properties of the soil of experimental field

Sl.No.	Particulars	Analytical values	Category	Methodology
A. Mechanical composition				
1	Sand %	24.02	Clay Sandy loam	International pipette method (Piper, 1967)
2	Silt %	19.83		
3	Clay %	56.15		
B. Chemical composition				
1	Organic carbon %	0.81	High	Walkey and Black method (Black,1965)
2	Available N (Kg/ha)	288.1	Medium	Alkaline Permanganate method (Jackson,1967)
3	Available P (Kg/ha)	20.38	High	Olsen method (Olsen *et al*, 1954)
4	Available K (Kg/ha)	170.45	Very low	Flame photometer method(Jackson, 1967)
5	Soil pH	5.93	Acidic	pH meter (Piper, 1967)
6	Electrical conductivity (ds/m^2 at 25°C)	0.26	Normal	Conductivity metresolu bridge method (Black, 1965)

3.5 Cropping history of the experimental filed

The following crops were grown during past eight years (Table 3.3).

Table 3.3 : Previous history of the experimental field.

Year	Crop (Kharif)	Crop (Rabi)
2002-03	Arhar	Fallow
2003-04	Paddy	Fallow
2004-05	Paddy	Fallow
2005-06	Fallow	Wheat
2006-07	Fallow	Wheat
2007-08	Fallow	Wheat
2008-09	Fallow	Wheat
2009-10	Paddy	Wheat
2010-2011	Paddy	Wheat
2011-2012	Paddy	Wheat

Experimental details

A.	Main treatment	:	5 (4 pruning intensities+1 open)
	P_0	:	No pruning (control)
	P_{25}	:	25% pruning
	P_{50}	:	50% pruning
	P_{75}	:	75% pruning
	Open	:	No tree (Crop only)
B.	Sub treatment	:	3 (Paddy Varieties)
	V_1	:	IR-36
	V_2	:	MR-219
	V_3	:	WGL-32100
	Design	:	Strip plot design
	Number of replications	:	Four
	Year of experimentation	:	Kharif, 2012
	Gross plot size	:	4.4 m x 4.4 m
	Net plot size	:	4m x 4m
	Distance between replication:		0.8 m
	Total number of plot	:	76
C.	Tree species	:	*Dalbergiasissoo*
	Tree spacing	:	5 m x 5m
	Row direction	:	East – West
	Year of plantation	:	Kharif, 1998

3.6 Observations recorded

■ **Tree**

Height (m)
Stem diameter at 1.37 meter above ground
Crown spread (m)

- Identification of major and minor insect pest of *Dalbergia sissoo* and Paddy.
- Population dynamic and period of infestation of insect pest on paddy with different shed of *Dalbergia sisso*.
- Population dynamic and period of infestation of insect pest of *Dalbergia sisso* with different pruning.
- Influence of change in climatic condition on population development.

3.7 Observations Recorded

The details of the observation recorded and the techniques employed are described below;

3.7.1 Growth observation on tree

***DalbergiaSissoo* (Shisham)**

*Dalbergia sissoo*Roxb.belong to family legumenaceae, commonly called as shisham. Shisham occurs naturally throughout the sub-Himalayan tract and outer Himalayan valley from the Indus to Assam. It is an important species having great value for furniture, joinery and carving. The foliage of tree is nutrition fodder. On account of its natural hardiness, fast growth and high timber value, the shisham has been widely used in afforestation and reforestation both in social forestry and agroforestry programmes throughout the India. It is planted in Nepal, Bhutan, Bangladesh, Myanmar, Malaysia, Pakistan, Afghanistan and in tropical to sub-tropical Africa.

Shisham is classifical example of a pioneer species in the riverian succession of the Genetic alluvium in India. The species occurs naturally on sandy and gravelly alluvial ground along the banks of rivers and stream. There is remarkable variation in growth pattern and the yield per unit area due to the wide adaptability of the tree in different ecological sites. The leaf fall begins in November-December and also depending upon the climatic conditions.

The mean temperature and humidity play an important role than rainfall in controlling leafing and flowering.

Growth of the tree (height, diameter at breast height and canopy spread).

The tree growth parameters were recorded to know the effect of management practices on the tree growth.

Height (m)

The height of individual tree in each block was measured from the ground level to the tip of the main stem with the help of a measuring tape. It is expressed in meter.

Diameter at Breast Height (cm)

Diameter at breast height (dbh) of individual tree of each block was measured with the help of diameter tape at 1.37 m above ground level. It is expressed in cm.

3.7.2 Seasonal incidence and population of insect pest of *Dalbergia sissoo.*

To note the succession and incidence of insect pest on *Dalbergia sissoo* the observation were recorded at weekly interval in the field condition starting from second week of July up to second week of November. The nature of damage of major / miner insect pest was also studied. The meteorological data of corresponding period of observation was also noted.

3.8 Statistical Analysis

The data calculated from the experiment were tabulated and analyzed statistically by method of analysis of variance as suggested by Cochran and Cox (1950).

The significance of the treatment mean square at 5 percent level was tested with 'F' test. When 'F' test showed the significance of treatment using the significance of critical differences at 5 per cent level further tested the differences between the treatment means.

Table 3.4: Skeleton for analysis of variance (ANOVA)

Source of variance	d.f.	SS	MSS	'F' Value		
				Calculated value	Tabulated Value	
					5%	1%
Replication	3				3.182	9.925
Main treatment pruning (T)	4				2.776	4.604
Error (a)	12				2.179	3.055
Sub treatment varieties of paddy (v)	2				4.303	9.925
Error (b)	6				2.447	3.707
Interaction (TxV)	8				2.306	3.355
Error (c)	24				2.064	2.797
Total	**59**					

$$\text{Mean sum of square (MSS)} = \frac{\text{Sum of squares}}{\text{Degree of freedom}} = \frac{\text{SS}}{\text{df}}$$

$$\text{'F' value} = \frac{\text{Treatment mean sum of squares (TMSS)}}{\text{Error mean sum of squares (EMSS)}}$$

$$\text{SEm± for main treatment (Pruning)} = \sqrt{\frac{E\ (a)}{RXV}}$$

CD =SEm± x 2 x $\sqrt{t5\%}$ for error (a) at 12 df

$$\text{SEm± for sub treatment (paddy varieties)} = \sqrt{\frac{E\ (b)}{RXT}}$$

CD = SEm± x 2 x $\sqrt{t5\%}$ for error (b) at 6 df

Interaction:

SEm± for comparison of two main treatments (pruning) at same level of sub treatment (paddy varieties)

$$SEm\pm = \sqrt{\frac{2\,[E(a) + (b-1)\,E(c)}{r \times b}}$$

$$CD = SEm\pm \times 2 \times \sqrt{t5\%} \text{ for error df of E(c)}$$

SEm± for comparism of two paddy varieties (v) at same level of main treatment of pruning (T):

$$SEm\pm = \sqrt{\frac{2\,[E(b) + (a-1)\,E(c)]}{r \times a}}$$

$$CD = SEm\pm \times 2 \times \sqrt{t5\%} \text{ for error df E (c)}$$

Where,

r	=	Number of replication
T	=	Number of main treatments (Pruning)
V	=	Number of sub treatment (paddy varieties)
E (a)	=	Error variance for main plot
E (b)	=	Error variance for subplot
E (c)	=	Error variance for interaction

3.9 Correlation studies:

Correlation of the abiotic factors on major insect pest population was worked out by using the formula as suggested by Snedecor and Cochran (1967).

$$r_{X_i X_j} = \frac{Cov X_i X_j}{\sqrt{(Var X_i)} . \sqrt{(Var X_j)}}$$

Where:

r_{xy} = simple correlation coefficient

x = meteorological parameter

y = incidence of insect pest and

n = number of observation

Test of significance of correlation coefficient

$$t = \frac{r}{\sqrt{(1 - r^2)}} X \sqrt{n - 2}$$

Where:

'n' is the number of sets of observations and 'r' is the correlation coefficient and value of 't' based on (n - 2) degree of freedom

RESULTS

The results on succession of Insect Pest association in *Dalbergia sissoo*, Paddy based Agrisilviculture system at Dusty Acres Research Farm, Department of Forestry, Jawaharlal Nehru KrishiVishwaVidyalaya, Jabalpur during Kharif season of 2012. Its infestation period, nature of damage and population dynamics are described in this chapter.

To study the succession of insect pest complex on *Dalbergia sissoo* and paddy during 2012

Studies on insect pest succession as it evident by the field incidence in four treatment (different pruning) respectively, revealed that about four species of insects on paddy and one on sissoo were observed to be associated upto 5 months (i.e. July to November) of rainy season at Jabalpur, Madhya Pradesh in Central India during 2012-13.

Table – 4.1 Succession of insect pest complex of paddy and *Dalbergia sissoo* during 2012

S. No.	Common Name	Scientific Name	Order	Family
Paddy				
1.	Leaf Folder	*Cnapholocrocis medinalis*	Lepidoptera	Pyralidae
2.	Brown Plant hopper	*Nilaparvata lugens*	Hemiptera	Delphacidae
3.	Paddy green leaf hopper	*N. virescens*	Hemiptera	Cicadellidae
4.	Gundhi Bug	*Leptocorisa oratorius*	Hemiptera	Alydidae
Dalbergia sissoo				
1.	Shisham defoliator	*Plecoptera reflexa*	Lepidoptera	Noctuidae

4.1 Distribution of insect pests (minor and major) on sissoo and paddy at Jabalpur 2012

4.1.1 Leaf Folder *Cnapholocrocis medinalis* (Lepidoptera : Pyralidae)

First appearance of the leaf folder on the paddy was observed on second week of August in all the four replication of crop habitats. The number of leaf folder on the paddy was worked out as weekly average per block from second week of August to fourth week of September.

These were small brownish orange coloured moths and have respectively, two and one distinct dark wavy lines on the brownish fore and hind wings which had a dark brown to gray band on their outer margin.

Larvae were yellowish to green in colour. They folded leaf margin longitudinally and fed the rolled leaves, larval period is 15-27 days, Pupation takes place inside the leaf roll (6-8 days). Total life cycle is 26-42 days. Eggs are laid singly or in pairs on the under surfaces of tender leaf blade; Incubation period is 4 – 7 days.

Nature of damage:

Leaf margins were folded longitudinally and fed the rolled leaves by scraping chlorophyll. The affected leaf dried up.

In a severely infested field the whole crop gave a sickly appearance with white patches. The infestation at boot leaf stage results in heavy loss of grain yield (Selvaraj K.).

4.1.2 Brown Plant hopper, *Nilaparvata lugens* (Delphacidae:Hemiptera)

First appearance of the Brown plant hopper on the paddy was observed on first week of August in all the four replication of crop habitats. The number of Brown plant hopper on the paddy was worked out as weekly average per block from first week of August to third week of September.

Adults were brown in colour, 4-5 mm long and more or less wedge shaped Macropterans are strong fliers and Hind tibia with a long movable spur.

Nature of damage:

Congregate at the base of the plant causing hopper burn.

4.1.3 Paddy green leaf hoppers *N. virescens* (Cicadellidae; Hemiptera)

During first week of August first appearance of the Paddy green leaf hoppers on paddy was observed in all the four replication of crop habitats. The number of Paddy green leaf hoppers on the paddy was worked out as weekly average per block from first week of August to third week of September.

Adult female inserts their eggs in rows under the epidermis of leaf sheath in groups of 5-20, up to 100-135 eggs. Eggs hatch in 5-7 days. Nymphal stage completed in 14-21 days.

- **Nature of damage:** The affected leaves and plants turn to yellow colour and growth is retarded. The nymphs and adults cause direct damage to rice crop by sucking sap from leaf sheaths and blades.

4.1.4 Gundhi Bug *Leptocorisa oratorius* (Hemiptera : Alydidae)

First appearance of the gundhi bug on the paddy was observed on third week of August in all the four replication of crop habitats. The number of gundhi bug on the paddy was worked out as weekly average per block from third week of August to second week of October.

Adults were brown coloured with prominent legs and antenna, Female lays eggs on the leaf blade in long rows of 10 -15 eggs. The nymphs are slender and greenish, Both nymphs and adults emit a foul smell after disturbance.

Nature of damage:

Suck the sap of the peduncle, tender stem and milky grains.

Symptoms:- Grains became chaffy. At the spot of the puncture water soaked spots appear and become brown with white center. The quality of the affected grain gets deteriorated. Apart from rice, they also breed on other grasses.

4.1.5 *Plecoptera reflexa*

It is commonly known as Shisham defoliator.It is a major pest of shisham. Caterpillar was semilooper, smooth, cylindrical, green in colour having eight bands on the dorsal side. The colour change on attaining advance stage. Mature larva is pinkish. Body length 25-30mm. Pupa is dark brown 20mm long. Eggs are pale yellow or green, circular or dome shaped 0.75mm in diameter. Grayish Forewings with oblique irregular bands, underside was grayish white. Wing expanse 30-35 mm.

Nature of damage:

Due to severe defoliation caused by the feeding, trees was stripped of their leaves and remain leafless for the greater part of growing season. After repeated attack, the infested trees shows dying tips and leading shoots.

- **Paddy**

1. Leaf Folder *Cnapholocrocis medinalis* (Lepidoptera : Pyralidae)
2. Brown Plant hopper, *Nilaparvata lugens* (Delphacidae:Hemiptera)
3. Paddy green leaf hopper *N. virescens* (Cicadellidae; Hemiptera
4. Gundhi Bug *Leptocorisa oratorius* (Hemiptera : Alydidae)

4.2.1 Leaf Folder *Cnapholocrocis medinalis* (Lepidoptera : Pyralidae)

Population dynamics

First appearance of the leaf folder on the paddy was observed on second week of August at the vegetative stage of paddy. Number of insects varied from block to block due to shade of sissoo in the open block number of insects were less because of more sunlight as compare to the block of 75%, 50%, 25% and no pruned tree.

Table 4.2 shows the result of population dynamics which started from second week of August that is shown in the form of standard meteorological week 33. The average number of insects in open block was 6.3 and under the 75%, 50%, 25% and no pruned tree in all four replications 6.4, 6.6, 6.9 and 7.5 respectively. The minimum and maximum temperature was 28.2^{o}C and 23^{o}C and the relative humidity was 89% in the morning and 81% in the evening.

Maximum population was recorded on the last week of September (36th meteorological week) where the insect population was 15.5, 15.6, 16.3, 16.8 and 17 respectively, in open condition, under the 75%, 50%, 25% and no pruned tree. The minimum and maximum temperature was 30.8°C and 23.9°C and the relative humidity was 93% in the morning and 89% in the evening.

Population of leaf folder in last week of September was observed 6.7, in open condition and 7.4, 8, 8.3 and 9,under 75%, 50%, 25% and no pruned tree and 9 in open condition. After this no insect was found. The minimum and maximum temperature was 31.9°C and 22.6°C and the relative humidity was 88% in the morning and 51% in the evening.

Average population of Rice leaf folder in all treatments and replications was 6.7, 7.8, 9, 16.2, 12.6, 10.7 and 7.8 in 33rd, 34th, 35th, 36th, 37th, 38th and 39th standard meteorological weeks respectively.

Table – 4.2 Seasonal incidence and population dynamic of Rice leaf folder

TreatmentS	Standard Meteorological Weeks						
	33	34	35	36	37	38	39
Pruning Intensities	**Incidence / Population**						
Po- No Pruning	7.5	8.8	10.7	17	14.1	11.2	9
P1-25% Pruning	6.9	8.4	10	16.8	13.3	10.8	8.3
P2-50% Pruning	6.6	7.8	8.8	16.3	12.8	10.6	8
P3-75% Pruning	6.4	7.4	8.1	15.6	11.8	10.5	7.4
Open- No tree	6.3	6.9	7.8	15.5	11.1	10.4	6.7
SEm±	0.1	0.2	0.2	0.6	0.5	0.2	0.3
CD (P=0.05)	0.4	0.7	0.7	NS	1.7	0.6	1
Paddy Varieties	**Incidence / Population**						
V1-IR36	6.7	7.9	9.3	16.2	13	10.7	8.1
V2-MR219	6.7	7.8	8.8	16.3	12.3	10.8	7.8
V3-WGL32100	6.9	7.9	9.3	16.2	12.6	10.7	7.8
SEm±	0.2	0.3	0.2	0.4	0.5	0.1	0.3
CD(P=0.05)	NS	NS	NS	NS	NS	NS	NS

Table:- 4.3 Correlation matrix of weather parameters with Rice leaf folder during (2012)

	Maximum Temperature	Minimum Temperature	Morning RH %	Evening RH %	Sun shine hrs	Rainfall (mm)	No. of Rainy Days	Wind velocity	Population of insect
Maximum Temperature	1								
Minimum Temperature	0.299	1							
Morning RH %	0.135	0.514	1						
Evening RH %	-0.509	0.309	0.627	1					
Sun shine hrs	0.763*	-0.291	-0.319	-0.864**	1				
Rainfall (mm)	-0.815**	-0.339	0.224	0.752*	-0.733*	1			
No. of Rainy Days	-0.905**	-0.313	0.199	0.649	-0.718*	0.899**	1		
Wind velocity	-0.394	0.098	-0.530	0.084	-0.413	0.025	0.081	1	
Population of insect	0.249	0.713*	0.559	0.720*	-0.759*	-0.006	-0.064	0.109	1

* Significant at 1% ** Significant at 5%

Correlation studies: (Table 4.3)

Positive correlation:

Maximum and minimum temperature, morning and evening relative humidity and wind velocity exhibited positive correlation (0.249, 0.713*, 0.559, 0.720* and 0.109 respectively) with leaf folder population, and minimum temperature and evening relative humidity found statistically significant at 1%.

Negative correlation:

Sunshine hours, rainfall and number of rainy days exhibited negative correlation (-0.759*, -0.006 and -0.064 respectively) with leaf folder population, Sunshine hours found to be statistical significant but rainfall and number of rainy days found non significant.

4.2.2 Brown Plant hopper, *Nilaparvata lugens* (Delphacidae:Hemiptera)

Population dynamics:

First appearance of the Brown Plant hopper on the paddy was observed on first week of August at the vegetative stage of paddy. Number of insects varied from block to block due to shade of sissoo at the open block number of insects were less because of more sunlight as compare to the block of 75%, 50%, 25% and no pruned tree.

Table 4.4 shows the result of population dynamics which started from first week of August that is shown in the form of standard meteorological week 32. The average number of insects in open block was 3.6 and under the 75%, 50%, 25% and no pruned tree in all four replications respectively 3.8, 4.1, 4.8 and 5.1. The minimum and maximum temperature was 27.7^{o}C and the relative humidity was 96% in the morning and 88% in the evening.

Maximum population was recorded on the last week of September (36th meteorological week) where the insect population was 6.8, 6.8, 7.6, 7.9 and 8 respectively in open condition, under the 75%, 50%, 25% and no pruned tree. The minimum and maximum temperature was 30.8^{o}C and the relative humidity was 93% in the morning and 89% in the evening.

Population of Brown Plant hopper in third week of September was observed 1, 1, 1.4, 1.6 and 1.8 open condition and under 75%, 50%, 25% and no pruned tree and 9 in open condition. After this Brown plant hopper was found. The minimum and maximum temperature was 30.8^{o}C and 23.9^{o}C and the relative humidity was 89% in the morning and 69% in the evening.

Average population of Brown plant hopper in all treatments and replications was 4.2, 4.3, 4.9, 6.0 7.4, 6.3 and 1.4 in 32nd, 33rd, 34th, 35^{th,} 36th, 37th and 38th standard meteorological weeks respectively.

Table – 4.4 Seasonal incidence and population dynamic of Brown Plant Hopper

Treatments	Standard Meteorological Weeks						
	32	33	34	35	36	37	38
Pruning Intensities	**Incidence / Population**						
Po- No Pruning	5.1	5.4	6	6.8	8	7.4	1.8
P1-25% Pruning	4.8	4.6	5.3	6.5	7.9	6.8	1.6
P2-50% Pruning	4.1	4.3	4.8	6.5	7.6	6.1	1.4
P3-75% Pruning	3.8	3.8	4	4.8	6.8	5.5	1
Open- No tree	3.6	3.6	4	4.8	6.8	5.5	1
SEm±	0.2	0.1	0.2	0.3	0.3	0.2	0.1
CD (P=0.05)	1.2	0.4	0.8	0.1	NS	0.7	0.3
Paddy Varieties	**Incidence / Population**						
V1-IR36	4.3	4.4	5.1	6	7.8	6.3	1.4
V2-MR219	4.3	4.3	4.8	6.1	7.3	6.4	1.5
V3-WGL32100	4.4	4.4	4.9	6	7.5	6.4	1.4
SEm±	0.3	0.1	0.3	0.2	0.2	0.2	0.2
CD(P=0.05)	NS	NS	NS	NS	NS	NS	NS

Table:- 4.5 Correlation matrix of weather parameters with Brown plant hopper during (2012)

	Maximum Temperature	Minimum Temperature	Morning RH %	Evening RH %	Sun shine hrs	Rainfall (mm)	No. of Rainy Days	Wind velocity	Population of insect
Maximum Temperature	1								
Minimum Temperature	0.853**	1							
Morning RH %	-0.271	-0.300	1						
Evening RH %	-0.455	-0.461	0.481	1					
Sun shine hrs	0.823**	0.554	-0.207	-0.696*	1				
Rainfall (mm)	-0.870**	-0.927**	0.469	0.726*	-0.755*	1			
No. of Rainy Days	-0.894**	-0.890**	0.306	0.587	-0.720*	0.890**	1		
Wind velocity	-0.642	-0.194	0.072	0.335	-0.797*	0.379	0.337	1	
Population of insect	0.280	0.163	0.377	0.533	-0.093	0.069	-0.012	-0.305	1

* Significant at 1% ** Significant at 5%

Correlation studies: (Table 4.5)

Positive correlation:

Maximum and minimum Temperature, Morning and evening relative humidity and rain fall exhibited positive correlation (0.280, 0.163, 0.377, 0.533 and 0.069 respectively) with Brown Plant hopper population, but statistically found non significant.

Negative correlation:

Sunshine hours number of rainy days and wind velocity exhibited negative correlation (-0.093, -0.012 and -0.305 respectively) with Brown Plant hopper population, but statistically to be non significant.

4.2.3 Paddy green leaf hoppers *N. virescens* (Cicadellidae; Hemiptera)

Population dynamics:

First appearance of the Paddy green leaf hoppers on the paddy was observed on first week of August at the vegetative stage of paddy. Number of insects varied from block to block due to shade of sissoo. The number of insects in open was less because of more sunlight as compare to the block of 75%, 50%, 25% and no pruned tree.

Table 4.6 shows the result of population dynamics which started from first week of August that is shown in the form of standard meteorological week 32 the minimum and maximum temperature was 27.7^{o}C and the relative humidity was 96% in the morning and 88% in the evening. The average number of insects in open block was 2.5 and under the 75%, 50%, 25% and no pruned tree in all four replications it was 2.7, 2.8, 3 and 3.5 respectively.

Maximum population was recorded on the last week of September (36th meteorological week) the minimum and maximum temperature was 30.8^{o}C and 23.9^{o}C and the relative humidity was 93% in the morning and 89 in the evening where the insect population was 10, 10.5, 10.6, 10.8 and 11.2 in open condition, under the 75%, 50%, 25% and no pruned tree respectively.

Population of Paddy green leaf hoppers in third week of September was observed 2.5, 2.7, 2.8, 3 and 3.5 open condition and under 75%, 50%, 25% and no pruned tree and 9 in open condition. After this no Paddy green leaf

hoppers was found. The minimum and maximum temperature was 30.8^{o}C, 23.9^{o}C and the relative humidity was 88% in the morning and 51% in the evening.

Average population of Green leaf hopper in all treatments and replications was 2.9, 4.8, 6.5, 7.8, 10.6, 9.5 and 2.9 in 32nd, 33rd, 34th, 35^{th,} 36th, 37th and 38th standard meteorological weeks respectively.

Table – 4.6 Seasonal incidence and population dynamic of Green Leaf Hopper

Treatments	Standard Meteorological Weeks						
	32	33	34	35	36	37	38
Pruning Intensities	**Incidence / Population**						
Po- No Pruning	3.5	5.3	7.3	8.3	11.2	9.9	3.5
P1-25% Pruning	3	5	7	8.1	10.8	9.8	3
P2-50% Pruning	2.8	4.9	6.5	7	10.6	9.6	2.8
P3-75% Pruning	2.7	4.6	6	7.7	10.5	9.4	2.7
Open- No tree	2.5	4.5	5.8	7.4	10	8.8	2.5
SEm±	0.2	0.2	0.2	1.2	0.2	0.4	0.2
CD (P=0.05)	NS	NS	0.5	NS	0.6	1.1	NS
Paddy Varieties	**Incidence / Population**						
V1-IR36	2.9	4.8	6.7	7.9	10.7	9.6	2.9
V2-MR219	2.9	5	6.7	7.9	10.6	9.6	2.9
V3-WGL32100	3	4.8	6.2	7.5	10.6	10.3	3
SEm±	0.1	0.2	0.3	0.2	0.5	0.2	0.1
CD(P=0.05)	NS	NS	NS	NS	NS	NS	NS

Table:- 4.7 Correlation matrix of weather parameters with Green Leaf hopper during (2012)

	Maximum Temperature	Minimum Temperature	Morning RH %	Evening RH %	Sun shine hrs	Rainfall (mm)	No. of Rainy Days	Wind velocity	Population of insect
Maximum Temperature	1								
Minimum Temperature	0.853**	1							
Morning RH %	-0.271	-0.300	1						
Evening RH %	-0.455	-0.461	0.481	1					
Sun shine hrs	0.823**	0.554	-0.207	-0.696*	1				
Rainfall (mm)	-0.870**	-0.927**	0.469	0.726*	-0.755*	1			
No. of Rainy Days	-0.894**	-0.890**	0.306	0.587	-0.720*	0.890**	1		
Wind velocity	-0.642	-0.194	0.072	0.335	-0.797*	0.379	0.337	1	
Population of insect	0.583	0.421	0.055	0.359	0.174	-0.238	-0.289	-0.460	1

* Significant at 1% ** Significant at 5%

Correlation studies: (Table 4.7)

Positive correlation:

Maximum and minimum Temperature, Morning and evening relative humidity and sunshine hours exhibited positive correlation (0.583, 0.421, 0.055, 0.359 and 0.174 respectively) with Paddy green leaf hopper's population, but statistically found non significant.

Negative correlation:

Rain fall, Number of rainy days and wind velocity showed a negative correlation (-0.238, -0.289 and -0.460 respectively) with Paddy green leaf hopper's population but statistically found non significant.

4.2.4 Gundhi Bug *Leptocorisa oratorius* (Hemiptera : Alydidae)

Population dynamics:

First appearance of the gundhi bug on the paddy was observed on fourth week of August. Number of insects varied from block to block due to shade of sissoo. At the open block, number of insects were less because of more sunlight as compare to the block of 75%, 50%, 25% and no pruned tree.

Table 4.8 shows the result of population dynamics which started from fourth week of August that is shown in the form of meteorological week 35. The average number of insects in open block is 5.8 and under the 75%, 50%, 25% and no pruned tree in all four replications 6, 6.5, 6.8 and 7.3 respectively. The minimum and maximum temperature was 31.9^{o}C, and 24.2^{o}C and the relative humidity was 92% in the morning and 69% in the evening.

Maximum population was recorded on the last week of September (39th standard meteorological week) where the insect population was 12.8, 13.8, 14.7, 15.9 and 16.8 in open condition, under the 75%, 50%, 25% and no pruned tree respectively. The minimum and maximum temperature was 31.9^{o}C and 22.6^{o}C and the relative humidity was 88% in the morning and 51% in the evening.

Population of gundhi bug in second week of October was observed 2.2, in open condition and 2.3, 2.4, 2.5 and 2.6 under 75%, 50%, 25% and no pruned tree and 9 in open condition. After this no gundhi bug was found. The

minimum and maximum temperature was 32.4^{o}C and 18.5^{o}C and the relative humidity was 83% in the morning and 35% in the evening.

Average population of Gundhi bug in all treatments and replications was 6.4, 6.6, 7.8, 11.7, 14.8, 7.6 and 2.4 in 34th, 35^{th,} 36th, 37th, 38th, 39th, 40th and 41st standard meteorological weeks respectively.

Table – 4.8 Seasonal incidence and population dynamic of Gundhi Bug.

Treatments	Standard Meteorological Weeks						
	35	36	37	38	39	40	41
Pruning Intensities	**Incidence / Population**						
Po- No Pruning	7.3	7.4	8.8	13	16.8	8	2.6
P1-25% Pruning	6.8	7	8.3	12.4	15.9	7.8	2.5
P2-50% Pruning	6.5	6.7	7.8	11.6	14.7	7.7	2.4
P3-75% Pruning	6	6.2	7.3	11.1	13.8	7.3	2.3
Open- No tree	5.8	5.8	7	10.8	12.8	7.2	2.2
SEm±	0.2	0.2	0.2	0.3	0.3	0.3	0.1
CD (P=0.05)	0.6	0.5	0.6	0.8	1	0.3	0.3
Paddy Varieties	**Incidence / Population**						
V1-IR36	6.7	6.7	7.8	11.9	15.1	7.6	2.4
V2-MR219	6.7	6.9	8.2	11.8	14.6	7.6	2.4
V3-WGL32100	6.2	6.4	7.6	11.7	14.8	7.6	2.4
SEm±	0.3	0.3	0.1	0.5	0.3	0.2	0.2
CD(P=0.05)	NS	NS	NS	NS	NS	NS	NS

Table:- 4.9 Correlation matrix of weather parameters with Gundhi bug during (2012)

	Maximum Temperature	Minimum Temperature	Morning RH %	Evening RH %	Sun shine hrs	Rainfall (mm)	No. of Rainy Days	Wind velocity	Population of insect
Maximum Temperature	1								
Minimum Temperature	-0.571	1							
Morning RH %	-0.296	0.863**	1						
Evening RH %	-0.841**	0.786*	0.731*	1					
Sun shine hrs	0.754*	-0.752*	-0.752*	-0.962**	1				
Rainfall (mm)	-0.676*	0.368	0.447	0.816**	-0.776*	1			
No. of Rainy Days	-0.763*	0.456	0.513	0.850**	-0.820**	0.837**	1		
Wind velocity	-0.812**	0.866**	0.567	0.775*	-0.657	0.436	0.558	1	
Population of insect	-0.225	0.491	0.180	0.104	0.052	-0.103	-0.069	0.668*	1

* Significant at 1% ** Significant at 5%

Correlation studies: (Table 4.9)

Positive correlation:

Minimum temperature, in the morning and evening relative humidity, Sunshine and wind speed exhibited positive correlation (0.491, 0.180, 0.104, 0.052 and 0.668* respectively) with the population of gundhi bug, wind velocity found to be statistically significant but Minimum temperature, morning and evening relative humidity and Sunshine hours found non significant.

Negative correlation:

Maximum temperature rainfall and number of rainy days exhibited negative correlation (-0.225 -0.103 and -0.069 respectively) with the population of gundhi bug, but found statistical non significant.

- ***Dalbergia sissoo***

4.2.5 Shisham defoliator *Plecoptera reflexa* (Leoidoptera:Noctuidae)

Population dynamics:

Maximum population was recorded during fourth week of July (30th standard meteorological week). Average number of insects on trees were 17.1 on 75% pruned trees, 23 on 50% pruned trees, 29.8 on 25% pruned trees and 34.1 on no pruned trees. The average temperature was 28.2^{o}C max. and 22.8^{o}C mim. and relative humidity was 95% in the morning and 88% in the evening.

Table 4.10 shows the variation of appearing of insects. 75% pruned trees have less insects then others like 50%, 25% and no pruned trees.

Population of insect were observed fourth in week of September average population was 2.6 per tree. After this week insects were observed but in very less number and on some trees no insect was recorded. The average temperature was 31.9^{o}C max. and 22.6^{o}C min. and relative humidity was 88% in the morning and in the evening 51%.

Average population of Shisham defoliator in all treatments and replications was 25.1, 23.7 , 21.7, 15.3, 13.8, 10.6, 8.5, 6.5, and 2.6 in 30th, 31st, 32nd, 33rd, 34th, 35th 36th 37th 38th and 39th standard meteorological weeks respectively.

Table – 4.10 Seasonal incidence and population dynamic of Plecoptera reflexa

Treatments	Standard Meteorological Weeks								
	30	31	32	33	34	35	36	37	38
Pruning Intensities	**Incidence / Population**								
Po- No Pruning	34.1	33.7	29.3	23.3	19.5	16.4	13.1	9.8	3.8
P1-25% Pruning	29.8	27.2	23.8	17.6	17.6	12	9.1	7.3	2.9
P2-50% Pruning	23	20.1	19.3	12.1	11.9	8.1	7.1	5.3	2.4
P3-75% Pruning	17.1	14.3	14.7	8.6	8.1	6.1	5.1	3.9	1.4
SEm±	0.3	0.3	0.3	0.3	0.2	0.2	0.1	0.1	0.1
CD (P=0.05)	1	0.8	1	1	0.5	0.7	0.4	0.3	0.5
Paddy Varieties	**Incidence / Population**								
V1-IR36	26.1	23.9	21.9	15.6	13.9	10.8	8.6	6.7	2.5
V2-MR219	25.9	23.6	21.4	15.2	13.9	10.4	8.5	6.6	2.6
V3-WGL32100	26.1	23.9	21.9	15.4	13.9	10.8	8.7	6.4	2.8
Tree alone (no crop)	25.8	23.7	21.8	15.5	13.8	10.5	8.6	6.5	2.7
SEm±	0.4	0.3	0.3	0.3	0.2	0.3	0.3	0.2	0.2
CD(P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table:- 4.11 Correlation matrix of weather parameters with *Plecoptera reflexa* during (2012)

	Maximum Temperature	Minimum Temperature	Morning RH %	Evening RH %	Sun shine hrs	Rainfall (mm)	No. of Rainy Days	Wind velocity	Population of insect
Maximum Temperature	1								
Minimum Temperature	0.702*	1							
Morning RH %	-0.576	-0.254	1						
Evening RH %	-0.627	-0.113	0.708*	1					
Sun shine hrs	0.819**	0.247	-0.553	-0.857**	1				
Rainfall (mm)	-0.569	-0.318	0.559	0.698	-0.559	1			
No. of Rainy Days	-0.835**	-0.519	0.590	0.742*	-0.742*	0.847**	1		
Wind velocity	-0.504	-0.171	0.209	0.309	-0.473	0.431	0.395	1	
Population of insect	-0.868**	-0.514	0.737*	0.646	-0.741*	0.547	-0.801**	0.371	1

* Significant at 1% ** Significant at 5%

Correlation studies: (Table 4.11)

Positive correlation:

Morning and evening relative humidity, rain fall and wind speed exhibited positive correlation (0.737*, 0.646, 0.547 and 0.371 respectively) with the population of *Plecoptera refexa*, Morning relative humidity found statistically significant but evening relative humidity rainfall and wind velocity found non significant, statically.

Negative correlation:

Maximum and minimum temperature, Sunshine and rainy days exhibited negative correlation (-0.868**, -0.514, -0.741* and -0.801** respectively) with the population of *Plecoptera reflexa.* Maximum temperature and rainy days found statistical highly significant. Sunshine hours found to be significant but minimum temperature found statistically non significant.

DISCUSSION

The study was conducted on the Insect Pest association in *Dalbergia sissoo*, Paddy based Agrisilviculture system at Dusty Acres Research Farm, Department of Forestry, Jawaharlal Nehru KrishiVishwaVidyalaya, Jabalpur during Kharif season of 2012. It's seasonal incidence, nature of damage and population dynamics. The results show obtained are discussed as under,

5.1 Insect Pest Complex

On Paddy

Four insect pests were recorded in four replication

1. Leaf Folder *Cnapholocrocis medinalis* (Lepidoptera : Pyralidae)
2. Brown Plant hopper, *Nilaparvata lugens* (Hemiptera: Delphacidae)
3. Paddy green leaf hopper *N. virescens* (Hemiptera: Cicadellidae)
4. Gundhi Bug *Leptocorisa oratorius* (Hemiptera : Alydidae)

On Sissoo

Shisham defoliator *Plecoptera reflexa* (Lepidoptera: Noctuidae)

5.2 Seasonal Incidence and Population Dynamics:

First appearance of the leaf folder on the paddy was observed on second week of August at the vegetative stage (tillering and panicle initiation stage of rice crop), Selvaraj K. (2010). Similar work was done by Arya K. (2012) the crop was observed to be more prone to leaf folder attack during pre flowering phase than post flowering. The number of leaf folder on the paddy was worked out as weekly average per block from second week of August to fourth week of September. Maximum population was recorded in first week of September. Average population of Rice leaf folder in all treatments and replications was 6.7, 7.8, 9, 16.2, 12.6, 10.7 and 7.8 in 33rd, 34th, 35^{th,} 36th, 37th, 38th and 39th standard meteorological weeks respectively.

The seasonal incidence of Brown plant hopper showed its presence during the growth stage of rice as conducted by Prashant T. (2012). Maximum population of the Brown plant hopper was recorded in first week of

September. First appearance was observed on first week of August in all the four replication of crop habitats. The number of Brown plant hopper on the paddy was worked out as weekly average per block from first week of August to third week of September. Average population of Brown plant hopper in all treatments and replications was 4.2, 4.3, 4.9, 6.0 7.4, 6.3 and 1.4 in 32nd, 33rd, 34th, 35^{th,} 36th, 37th and 38th standard meteorological weeks respectively.

Paddy green leaf hopper is a major pest of rice, Pawan K. (2012). First appearance of the Paddy green leaf hoppers on the paddy was observed on first week of August in all the four replication of crop habitats. The number of Paddy green leaf hoppers on the paddy was worked out as weekly average per block from first week of August to third week of September at good vegetative stage. Maximum population of Paddy green leaf hopper was recorded in first week of September Average population in all treatments and replications was 2.9, 4.8, 6.5, 7.8, 10.6, 9.5 and 2.9 in 32nd, 33rd, 34th, 35^{th,} 36th, 37th and 38th standard meteorological weeks respectively.

First appearance of the Gundhi bug on the paddy was observed on third week of August in all the four replication of crop habitats. The number of gundhi bug on the paddy was worked out as weekly average per block from third week of August to second week of October. Average population of Gundhi bug in all treatments and replications was 6.4, 6.6, 7.8, 11.7, 14.8, 7.6 and 2.4 in 34th, 35^{th,} 36th, 37th, 38th, 39th, 40th and 41st standard meteorological weeks respectively. Maximum population of Gundhi bug is recorded in fourth week of September.

Plecoptera reflexa is the most harmful, causing defoliation. Maximum population of Shisham defoliator was recorded during fourth week of July (30th Meteorological week). Average number of insects on trees was 17.1 on 75% pruned trees, 23 on 50% pruned trees, 29.8 on 25% pruned trees and 34.1 on no pruned trees. The average temperature was 28.2^{o}C max. and 22.8^{o}C mim. And relative humidity was 95% in the morning and in the evening 88%. Average population of Shisham defoliator in all treatments and replications was 25.1, 23.7 , 21.7, 15.3, 13.8, 10.6, 8.5, 6.5, and 2.6 in 30th, 31st, 32nd, 33rd, 34th, 35th 36th 37th 38th and 39th standard meteorological weeks respectively.

5.3 Stastically Significant Data

5.3.1 Leaf Folder *Cnapholocrocis medinalis* (Lepidoptera : Pyralidae)

Correlation studies between various abiotic factors and Leaf folder had significant positive correlation with minimum temperature and evening relative humidity (0.713* and 0.720*) and sunshine hours found significant negative correlation.

5.3.2 Brown Plant hopper, *Nilaparvata lugens* (Delphacidae:Hemiptera)

Correlation studies of weather parameter with Population dynamics of Brown plant hopper is revealed that maximum and minimum temperature, morning and evening relative humidity, sunshine rainfall, number of rainy days and wind velocity had no significant positive and negative correlation with the insect pest population.

5.3.3 Paddy green leaf hoppers *N. virescens* (Cicadellidae; Hemiptera)

Correlation studies of weather parameter with Population dynamics of paddy green hopper is revealed that maximum and minimum temperature, morning and evening relative humidity, sunshine rainfall, number of rainy days and wind velocity had no significant positive and negative correlation with the insect pest population.

5.3.4 Gundhi Bug *Leptocorisa oratorius* (Hemiptera : Alydidae)

Only the wind velocity had the significant positive correlation with Gundhi bug. Maximum and minimum temperature, morning and evening relative humidity, sunshine rainfall, number of rainy days and wind velocity had no significant positive and negative correlation with the insect pest population.

5.3.5 Shisham defoliator *Plecoptera reflexa* (Leoidoptera:Noctuidae)

Correlation studies of weather parameter with Population dynamics of Shisham defoliator had significant positive correlation is revealed that morning relative humidity (0.737) and significant negative correlation with maximum temperature, sunshine and number of rainy days (-0.868**, -0.741* and -0.818** respectively).

5.4 Occurrence of insect pest depends on following

Occurrence of insect pest is mainly depend on the stage of crop and climatic condition. Particular insect attacks the crop (either it is agricultural crop or forest trees) at the particular stage. Insect pest population is also influenced by the different shade or sunlight.

Stage of crop

Brown Plant hopper, Paddy green leaf hoppers and Leaf folder attack the crop at vegetative stage (tillering and panicle initiation stages of rice crop) K. Selvaraj. These pests occurs after 15 days when crop is in good vegetation and remains whenever crop may not got maturity. Some time the effect of these insects become a serious problem. Brown Plant hopper and Paddy green leaf hoppers feed the leaves of crop resulting loss of vegetation and decreasing the rate of photosynthesis. Leaf folder also attacks at vegetative stage of crop. Leaf margins are folded longitudinally and feed the rolled leaves by scraping chlorophyll. The affected leaf dries up. In a severely infested field the whole crop gives a sickly appearance with white patches. The infestation at boot leaf stage results in heavy loss of grain yield.

Effect of pruning intensity

The insect pest influenced with the different pruning. The number of insect pest under the tree is directly or indirectly depend on shade of tree. The result shows more shade more the population. Under the 75% pruned tree less number of insect (Brown Plant hopper, Paddy green leaf hoppers Leaf folder and gundhi bug) found. Minimum number of insects are observed in open condition and maximum number of insects are observed under the tree of no pruned tree.

Effect of pruning has also role in the population of insect pest of sissoo. *Plecoptera reflexa* is a major pest of shisham commonly it is known as shisham defoliator found from the first observation. Result shows the increase in number of population as the pruning is decreasing. Maximum number of *Plecoptera reflexa* is observed on the tree which is less pruned.

Paddy varieties

Under the investigation three varieties are taken IR-36, MR-219 and WGL-32100 and the result shows there are not so much difference in insect pest population and occurrence.

Agroclimatic variations

Besides the influence of different treatment tried under the investigation, the prevailing weather condition such as total rainfall, number of rainy days, temperature, relative humidity, light and wind velocity during the crop season have great apprehension with the insect pest.

Weather Condition

The weather condition prevailed during the year 2012 are described in table-1. According to prevailing weather parameters maximum and minimum temperature deviated during the growing season. As regards total rainfall received during growing season was 1282.1 mm with 43 numbers of rainy days. During the year total rainfall was received was 1282.10 mm which was more or less same with average rainfall 1300 mm, High humidity and optimum temperatures are conducive factors for the rapid multiplication of the pest. The population of gundhi bug build up is usually noticed at the end of rainy season and declines rapidly during dry months when temperatures are unfavorable. The maximum population of gundhi bug is usually observed during September. Due as a result not so in fluctuation the number of insect pest is normal and not so much loss due to infestation. Temperature 27 –28°C Relative Humidity 80-82%. Flowering stage warm and cloudy weather and frequent drizzles favour population build up. Extensive weedy areas near rice fields and staggered rice planting favour high population. Heavy rains reduce population.

Edaphic Condition

As the soil was medium in nitrogen, high in phosphorus and low in potash have not much support to the crop plant and for food supply. The soil characteristics and soil environment considerably affect the population of insect. Use of heavy doses of nitrogenous fertilizers. heavy irrigation with constant standing water use of heavy pesticides resulting in resurgence.

Continuous cropping of paddy (in both the seasons, monocropping) Close planting will result in prevention of aeration & light causes for outbreak of Brown Plant hopper. Rice leaf folder occurs in abundance where ‘N’ fertilizer dose increase.

SUMMARY, CONCLUSIONS AND SUGGESTIONS FOR FURTHER WORK

Insect pest association in *Dalbergia sissoo* and paddy studies revealed that five different insect pest were observed (four on paddy and one on sissoo).The group of insect pest observed at the vegetative stage of paddy were Paddy green leaf hoppers *N. virescens* (Hemiptera), Brown plant hopper *Nilaparvata lugens* (Hemiptera) and Rice leaf folder *Cnapholocrocis medinalis* (Lepidoptera) from first week of August to fourth week of September and in reproductive stage Gundhi bug *Leptocorisa oratorius* (Hemiptera) was recorded from fourth week of August to second week of October. Shisham defoliatior *Plecoptera reflexa* (Lepidoptera) was observed from fourth week of July to fourth week of September. No insect pest was found which was common in sissoo and paddy.

Seasonal incidence and population dynamics of insect pest of paddy viz. Rice leaf folder *Cnapholocrocis medinalis* (Lepidoptera) was appeared on second week of August and observed from 33rd SW to 39th SW. Correlation studies between various abiotic factors and Leaf folder had significant positive correlation with minimum temperature and evening relative humidity (0.713* and 0.720*) and sunshine hours found significant negative correlation. Brown plant hopper *Nilaparvata lugens* (Hemiptera) was also observed at vegetative stage of paddy from first week August 32nd SW to third week of September 38th SW. Correlation studies of weather parameter with Population dynamics of Brown plant hopper is revealed that maximum and minimum temperature, morning and evening relative humidity, sunshine rainfall, number of rainy days and wind velocity had no significant positive and negative correlation with the insect pest population. Paddy green leaf hopper *N. virescens* (Hemiptera) was observed at vegetative stage of paddy from second week August 33rd SW to fourth week of September 39th SW. Correlation studies of weather parameter with Population dynamics of paddy green hopper is revealed that maximum and minimum temperature, morning and evening relative humidity, sunshine rainfall, number of

rainy days and wind velocity had no significant positive and negative correlation with the insect pest population. Gundhi bug *Leptocorisa oratorius* (Hemiptera) was observed at reproductive stage of paddy from fourth week August 35th SW to second week of October 41th SW. Only the wind velocity had the significant positive correlation with Gundhi bug. Maximum and minimum temperature, morning and evening relative humidity, sunshine rainfall, number of rainy days and wind velocity had no significant positive and negative correlation with the insect pest population. Number of insect pest is less in open condition as compare to with tree having block. Shisham defoliatior *Plecoptera reflexa* (Lepidoptera) was observed from fourth week of July 30th SW to fourth week of September 39th SW. Correlation studies of weather parameter with Population dynamics of Shisham defoliator had significant positive correlation is revealed that morning relative humidity (0.737) and significant negative correlation with maximum temperature, sunshine and number of rainy days (-0.868**,-0.741*and -0.818** respectively). Shisham defolitor was observed in more number in less and no pruned tree.

6.1. Suggestions for further work

It is necessary to identify the status of various insect pest of paddy and sissoo and has become very essential to concentrate or focus on the shading effect and association.

From the present study it is evident that rice leaf folder on paddy and shisham defoliator on sissoo are gaining importance. Hence research work should be initiated on these two insect pest. Brown plant hopper and green leaf hopper are also important pest of paddy.

The present work sufficiently gives an indication that the shisham defoliator attacks in the monsoon and rice leaf folder and hoppers appear on paddy at the growth stage of crop gundhi bug damages the crop in milking stage.

Present investigation also gives the knowledge about different shade effect on insect pest population. The result shows the maximum population in higher shed and less population in open condition.

This work should be further continued so as to study the impact of shade on yield loss, infestation and damage percent due to insect pest.

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APPENDIX-I

Seasonal incidence and population dynamics of insect pest of paddy and sissoo

SW	Rice leaf foldr					Brown plant hopper					Green lead hopper					Gundhi bug					Shisham defolitor			
	P0	P25	P50	P75	Open	P0	P25	P50	P75	Open	P0	P25	P50	P75	Open	P0	P25	P50	P75	Open	P0	P25	P50	P75
30	-	-	-	-	-	-	-	-	-	-	--	-	-	-	-	-	-	-	-	-	34.1	29.8	23	17.1
31	-	-	-	-	-	-	-	-	-	-	--	-	-	-	-	-	-	-	-	-	33.7	27.2	20.1	14.3
32	-	-	-	-	-	5.1	4.8	4.1	3.8	3.6	3.5	3	2.8	2.7	2.5	-	-	-	-	-	29.3	23.8	19.3	14.7
33	7.5	6.9	6.6	6.4	6.3	5.4	4.6	4.3	3.8	3.6	5.3	5	4.9	4.6	4.5	-	-	-	-	-	23.3	17.6	12.1	8.6
34	8.8	8.4	7.8	7.4	6.9	6	5.3	4.8	4	4	7.3	7	6.5	6	5.8	-	-	-	-	-	19.5	16.1	11.9	8.1
35	10.7	10	8.8	8.1	7.8	6.8	6.5	6.5	4.8	4.8	8.3	8.1	7	7.7	7.4	7.3	6.8	6.5	6	5.8	16.4	12	8.1	6.1
36	17	16.8	16.3	15.6	15.5	8	7.9	7.6	6.8	6.8	11.2	10.8	10.6	10.5	10	7.4	7	6.7	6.2	5.8	13.1	9.1	7.1	5.1
37	14.1	13.3	12.8	11.8	11.1	7.4	6.8	6.1	5.5	5.5	9.9	9.8	9.6	9.4	8.8	8.8	8.3	7.8	7.3	7	9.8	7.3	5.3	3.9
38	12.2	10.8	10.6	10.5	10.4	1.8	1.6	1.4	1	1	3.5	3	2.8	2.7	2.5	13	12.4	11.6	11.1	10.8	3.8	2.9	2.4	1.4
39	9	8.3	8	7.4	6.7	-	-	-	-	-	-	-	-	-	-	16.8	15.9	14.7	13.8	12.8	-	-	-	-
40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	7.8	7.7	7.3	7.2	-	-	-	-
41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.6	2.5	2.4	2.3	2.2	-	-	-	-

APPENDIX-II

Mean sum of square for different morphological characters and of Shisham

Sources of Variance	df	MSS			
		Height(m)	dbh(cm)	Canopy spread (m)	
				N-S	E-W
Replication	3	2.0	25.4	72.3	2.0
Pruning (P)	3	8.7	146.2	6.8	8.7
Error (a)	9	0.8	8.3	3.8	0.8
Paddy varieties (V)	3	1.8	25.4	7.5	1.8
Error (b)	9	0.9	7.4	4.7	0.9
Interaction (PxV)	9	0.7	13.8	4.0	0.7
Error (c)	27	4.5	67.4	13.3	4.5

PLATE - 1

Experimental field

PLATE - 4

Paddy green leaf hopper*N. virescens* (Hemiptera:Cicadellidae)

Paddy green leaf hopper*N. virescens* (Hemiptera:Cicadellidae)

PLATE - 2

Leaf Folder*Cnapholocrocis medinalis* (Lepidoptera : Pyralidae)

PLATE - 5

Gundhi Bug *Leptocorisa oratorius* (Hemiptera : Alydidae)

PLATE - 6

Leaves affected by *Plecoptera reflexa*

Shisham defoliator*Plecoptera reflexa* (Lepidoptera:Noctuidae)

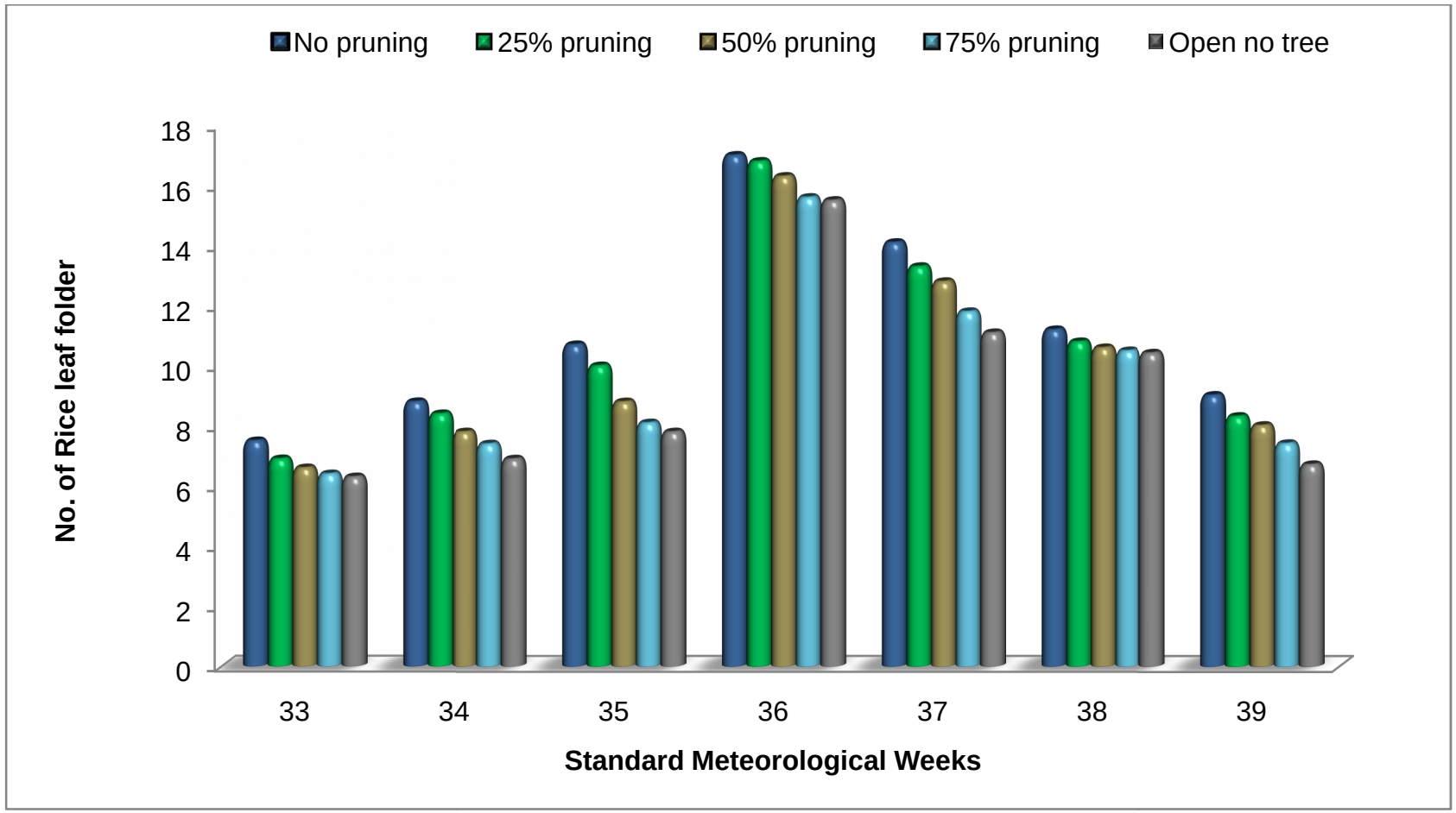

Fig. 3Seasonal incidence and population dynamic of Rice leaf folder.

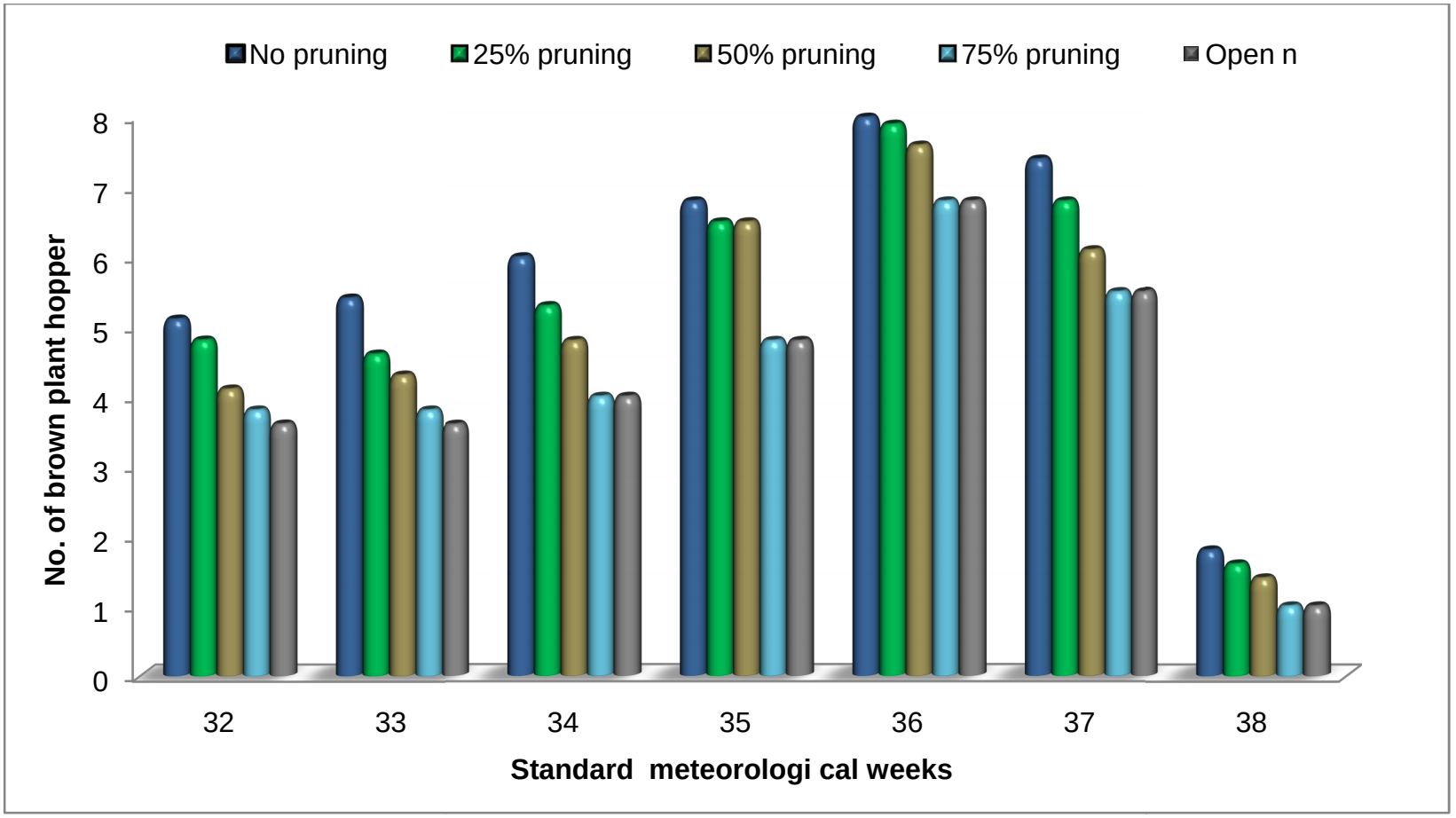

Fig. 4: Seasonal incidence and population dynamic of Brown plant hopper

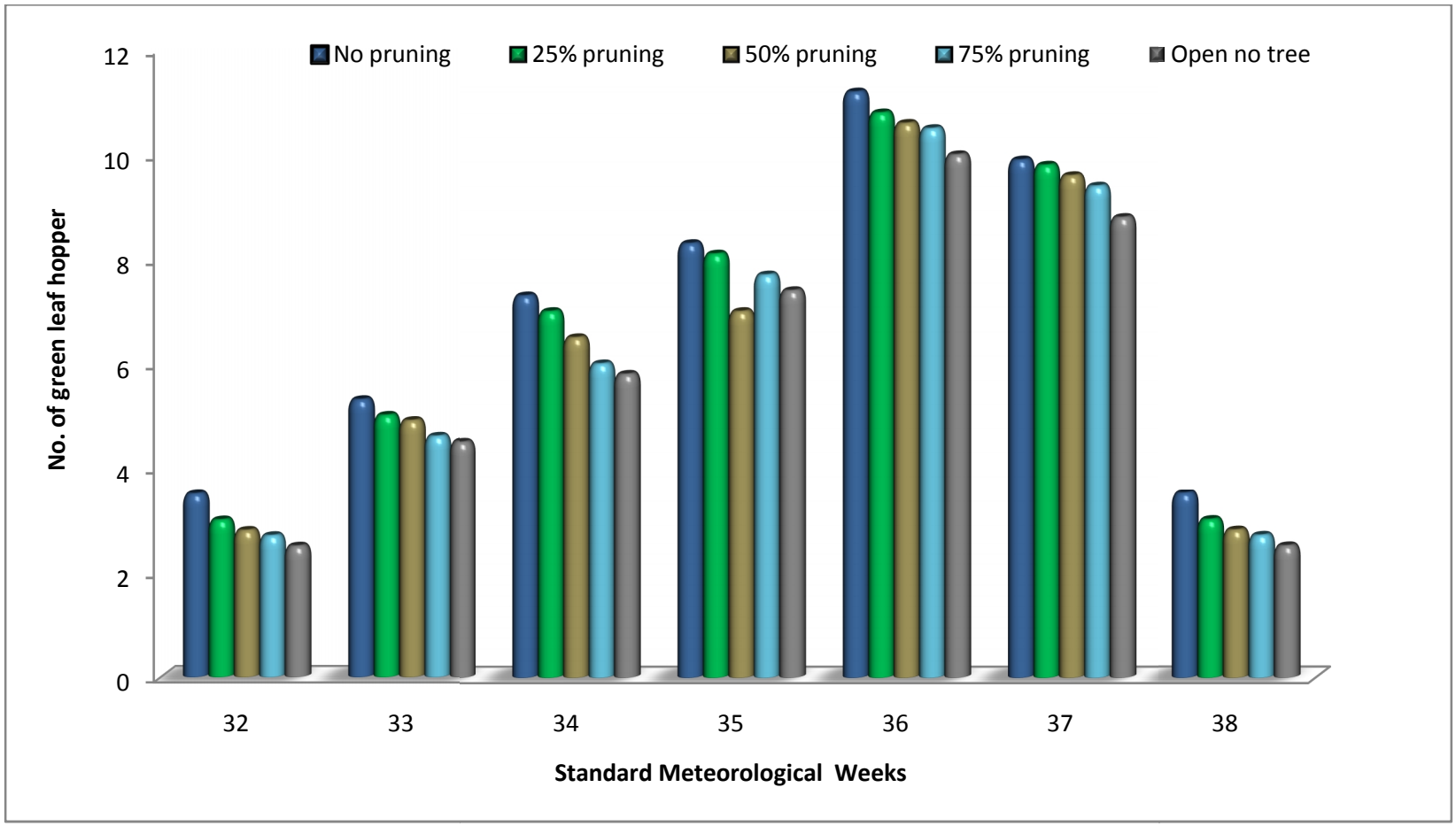

Fig. 5: Seasonal incidence and population dynamic of Green leaf hopper

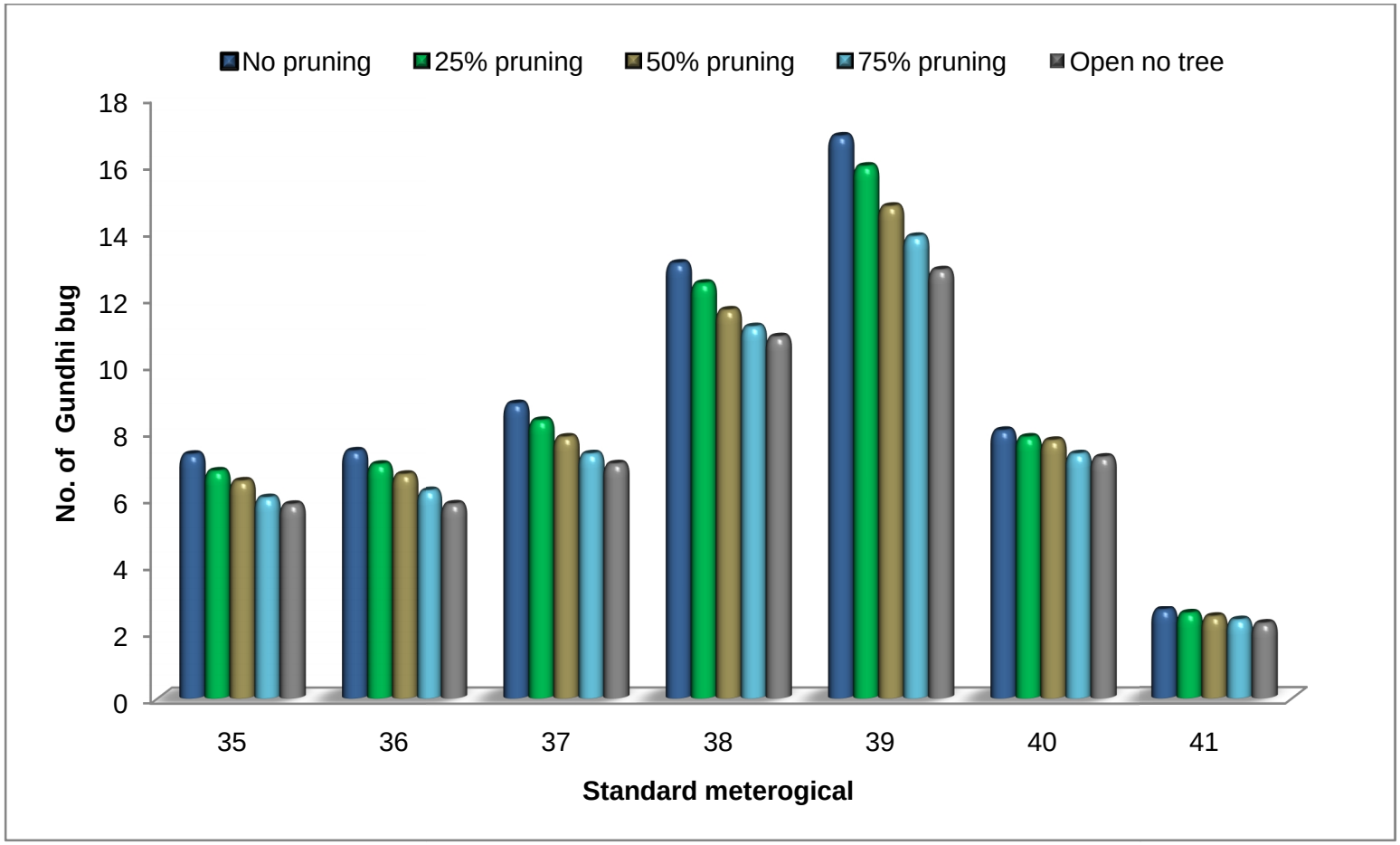

Fig. 6: Seasonal incidence and population dynamic of Gundhi bug.

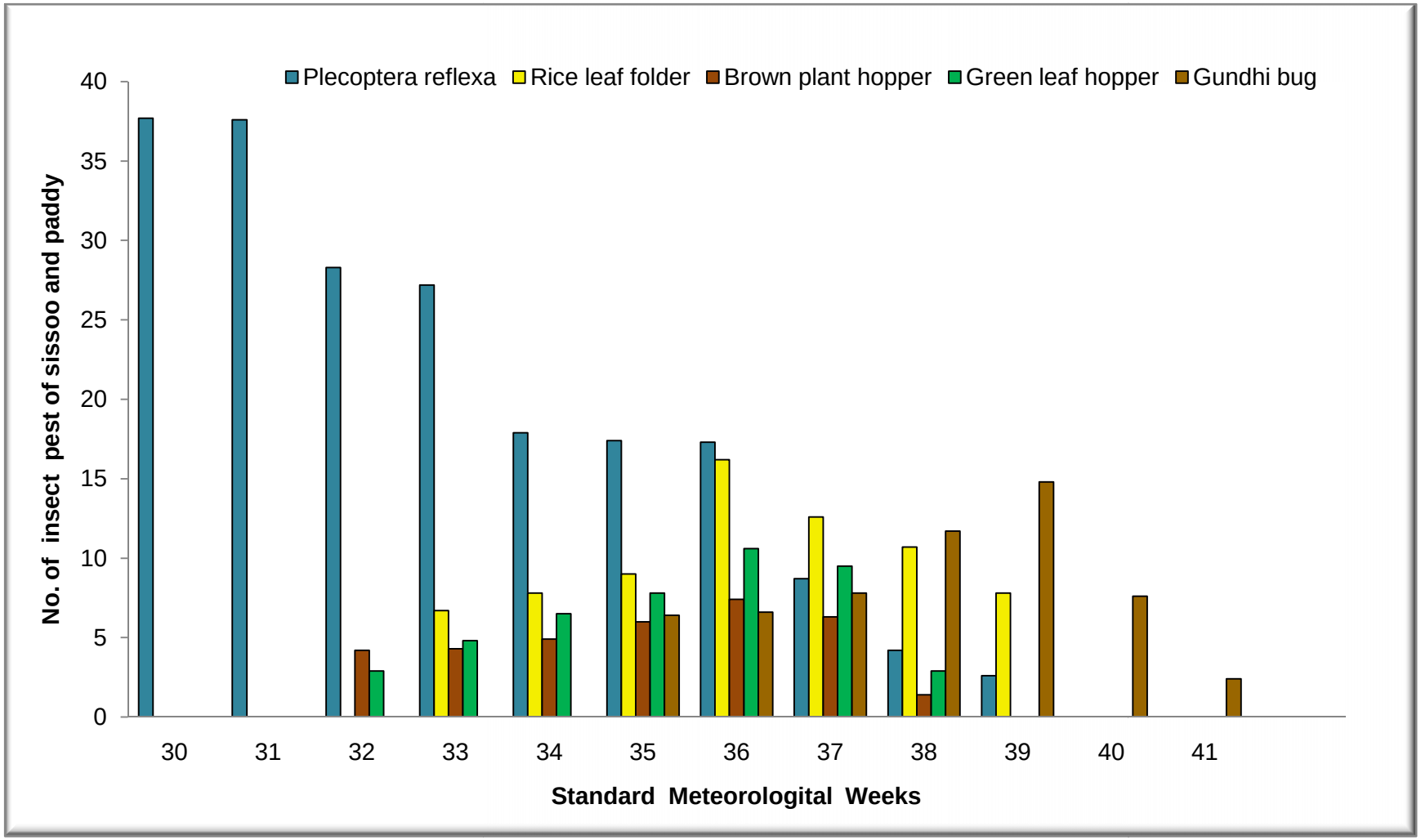

Fig. 8 : Seasonal incidence and population dynamics of insect pest of *Dalbergia sissoo* and paddy.

VITA

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(Chandan Manjhi)