PRELIMINARY STUDIES ON INSECT VISITORS TO TEAK (*TECTONA GRANDIS* LINN. F) INFLORESCENCE IN LET-PAN-KHON TEAK CLONAL SEED ORCHARD, OKTWIN TOWNSHIP

Khin Mar Myint[1]
Dr. Myint Thaung[2]
Dr. Aung Kyi[3]

ABSTRACT

A survey was conducted at Let-pan-khon Teak Clonal Seed Orchard, Oktwin Township, Bago Division to observe insect visitors to teak flowers in 2001 and 2002 flowering seasons. A total number of 31 insect species from 22 Families of four Orders were recorded. Data of insect collection on individual visit at different sites were presented in Appendix I. The most abundant visitors were found to be Lepidopterans and the least Coleopterans. Apart from those of Coleoptera, other insects are believed to be beneficial. In terms of species richness, Hymenoptera was the most, and it included 13 species from 8 families. Lepidoptera included 9 species from 5 families; Diptera- 6 species from 6 families, and Coleoptera was very poor, only 3 species from 3 families. This study suggests that insects were visiting teak flower for the whole day. However, most of the insects were active only at the early hours of the day, i.e. from 8:00-10:00 am. The number of insect visitors decreased with transfer of time. It was true in this study. More insects were visiting to flowers in July than in August. It is recommended to keep artificial beehives at the periphery of the teak plantations. By doing this, pollination of teak flower could be enhanced to some extent and consequently more fruit setting could be expected. On the other hand, income of the employees actively involved in the plantation could also be increased.

[1] Research Assistant (2), Forest Research Institute
[2] Professor, Agricultural University
[3] Associate Professor, Agricultural University

1. INTRODUCTION

Teak is primarily an out crossing species, but self-pollination is possible (Bryndum and Hedegart 1969; Hedegart 1973). The extent of self-incompatibility in teak varies from 96-100% (Hedegart 1973), and commonly less than 1% of self-pollinated flowers develop into fruits (Hedegart, 1976).

Fruit production and germination of seeds in teak was reported to be extremely poor in Myanmar (Maung Gale (2), 1958). Fruit production has been considered to have relationship with the age of seed bearing trees (Kermode, 1964). It is a good start to get enough quantities of good seeds bearing desirable genetic characters for the development of extensive plantation, in this regard, pollination by insects becomes a focal point for the fertilization of teak flowers.

A study in pollination of Teak in Thailand clearly indicated that higher result of fruit setting in controlled pollination is obtained during the period of 11:30-13:00 are compared with that from earlier or later of this period (Bryndum and Hedegart 1969; Hedegart 1973).

The study in India showed that 17 species of insects from Hymenoptera, Diptera and Lepidoptera were recorded as insect visitor to teak. Among them the majority (13 spp) was Hymenoptera. The insect activity was greater during the cooler morning hours (08:00- 10:00 h) than the rest of the day until 17:00 hr. (Mathew et. al, 1987).

Although there are several studies on the insect pollinators of agricultural crops (Batra, 1967; Kakar and Sharma, 1978; Rahman 1940; Bhalla et al., 1984), little seems to have been done on this line with regard to the forest tree species. This is true in the case of teak as well. The present study was made mainly to gather information on the insects that visit teak inflorescence.

It is essential to investigate the species composition of insect visitors and their abundance in teak plantation and their activity at different time of the day so as to exploit their behaviour in getting more fruit set at the Clonal Seed Orchards.

The objectives of this study are:

- to record the species composition and abundance of insect visitors to teak,
- to evaluate the activity of insects at different time of the day, and
- to compare the number of insect visitors in July and August.

2. LITERATURE REVIEW

Teak is mainly an insect pollinated species but wind pollination also occurs in this species (Horme 1961, Bryndum and Hedegart 1969, Cameron 1968, Egenti 1974, Kerdarnath 1974, Tangmitcharoen and Owens 1996). There is a close relation between the percentage of fruit setting per flower panicle and the number of visits of insect pollinators. That is, the fruit percentage increases singly with an increase in number of visits of the pollinators (Hedegart 1973, Egenti, 1974, Egenti, 1981).

Bees, flies, butterflies and ants are major pollinators in this species. However ant pollination systems are remarkably rare (Beatiee et al, 1984).

The natural pollination of Teak is mainly affected by insects, particularly by two species of Apidae (*Heriades parvula* and *Ceratina hieroglyphica*) (Hedegart 1973). These major pollinators are *Ceratina* spp which carry pollen on most parts of their bodies, especially on the tibia. The most effective pollination period, in terms of flowers pollinated and pollen per flower, is between 09:00 and 13:00 hr. The main cause of low fruit set is lack of insect pollinators and their effectiveness. Although 78% of flowers are pollinated in open pollination, there is a high rate of selfing (Tangmitcharoen and Owens, 1996). Higher result of fruit setting in controlled pollination is obtained during the period of 11:30-13:00 as compared with that from earlier or later of this period (Bryndum and Hedegart, 1969. Hedegart. 1973). During this peak pollination period, abundance of visible pollen grains are released from the anther and be ready to be transferred by the pollinators (Hedegart, 1973).

3. MATERIALS AND METHODS

The study was conducted at the teak clonal seed orchard, Latpankhon, Oktwin Township (18° 15' N and 96° 18' E) in 2001 and 2002. Two study sites, i.e. D_2 block and D_4 block were selected in 2001 survey and another study site, B_5 block was chosen in 2002 (Fig. 1). Site D_2 and D_4 block were planted in 1981 and B_5 block in 1982, respectively. At the time of survey plantations were already 20 to 21 years old.

From each study site, one teak tree was randomly selected and a bamboo scaffold was set up to reach the height of flowering parts. Insects visiting flowers were collected using a sweep net. The time of insect collection was divided into four periods, such as 8:00 to 10 a.m.; 10-12 noon; 12-14 pm and 14-16 pm. Insects caught were brought to the laboratory for identification and inspection of teak flower pollens on different parts of the body.

4. ANALYSIS

All data were subjected to analysis using principal component analysis and multivariate analysis of variance (MANOVA). Principal component analysis was used to know the most important variable. In this study different species of insects from four insect orders and four different periods of insect species visiting teak flowers at two study sites. Principal component analysis can be applied to reduce the complexity of dimensional data from high into a few dimensions so that the most important variable can be clearly observed from all observed variables.

Multivariate analysis of variance (MANOVA) can also be used to measure some combinations of response variables by replacing several variables. In this study the hypotheses to be tested were H_0 : no different period effect, H_0 : no different site effect, H_0 : no different period versus different sites interaction effects.

5. RESULTS AND DISCUSSION

A total number of 31 insect species from 22 Families of four Orders were recorded from this survey (Table 1)**.** Data on insect collection on individual visit at different sites were presented in Appendix (I, II, & III). The most abundant visitors were found to be Lepidopterans and the least Coleopterans. Apart from those of Coleoptera, other insects are believed to be beneficial insects. In terms of species richness, Hymenoptera was the most, and it included 13 species from 8 families. Lepidoptera included 9 species from 5 families; Diptera- 6 species from 6 families, and Coleoptera was very poor, only 3 species from 3 families.

Table (1) Insects Visitors to *Tectona grandis* Flower Collected at Letpankhon (Teak Clonal Seed Orchard)

Order	**Hymenoptera**
Suborder	Apocrita
Family	Sphecidae
Species	
(1)	*Ammophilia nigricans*
(2)	*Sphex ichneumoneus*
(3)	*Sphex* Spp
Subfamily	Nyssonine
(4)	Nyssonine wasp
Family	Apidae
Subfamily	Bombinae
(5)	*Bombus* Spp (Bumble bee)
Family	Anthophoridae
(6)	Anthophorine bee (digger bee)
Subfamily	Xylocopinae
(7)	*Xylocopa* Spp (Carpenter bee)
(8)	*Ceratina* Spp (Small carpenter bee)
Family	Ichneumonidae
(9)	Ichneumonid wasp
Family	Scoliidae
(10)	*Campsomeris* Spp
Superfamily	Vespoidea
Family	Eumennidae
(11)	*Abispa* Spp
Family	Vespidae
(12)	*Polistes* Spp
Family	Pompilidae
(13)	*Crytocheilus* Spp
Order	**Diptera**
Family	Syrphidae
Species	
(1)	*Eristalis tenax* (Syrphid fly)
Family	Mydaidae
(2)	*Mydas clavatus* (Mydas fly)
Family	Calliphoridae
(3)	*Amenia imperialis dubitalis* Mall

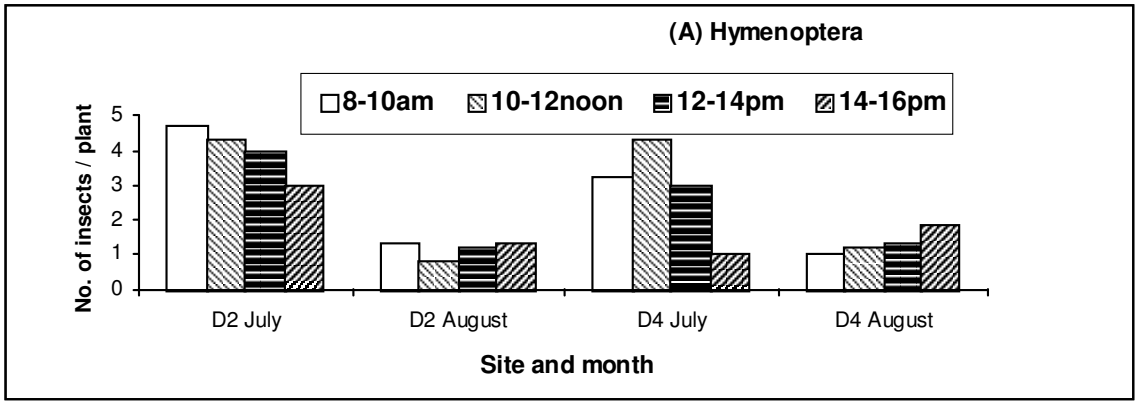
Family Milichiidae
(4) *Milichiilla* spp
Family Dexiidae
(5) *Dexia Ventralis*
Family Sarcophagidae
(6) *Tricholioproctia hardyi*
Order Lepidoptera
Family Pieridae
Species
(1) Pieris brassicae
(2) *Pieris* spp
Family Danaidae
(3) *Euploea* spp
(4) *Danaus plexippus*
Family Papilionidae
(5) *Atrophaneura* spp
(6) *Danaus similis*
Family Nymphalidae
(7) Cethosia penthesilea
(8) *Moduza procris milonia*
Superfamily Sphingoidea
Family Sphingidae
Subfamily Macroglossinae
(9) *Macroglossum aquila*
Order Coleoptera
Family Cerambycidae
Species
(1) *Phoracantha semipunctata*
Family Meloidae
(2) *Mylabris* sp, Blister beetle
Family Lampyridae
(3) Fire fly

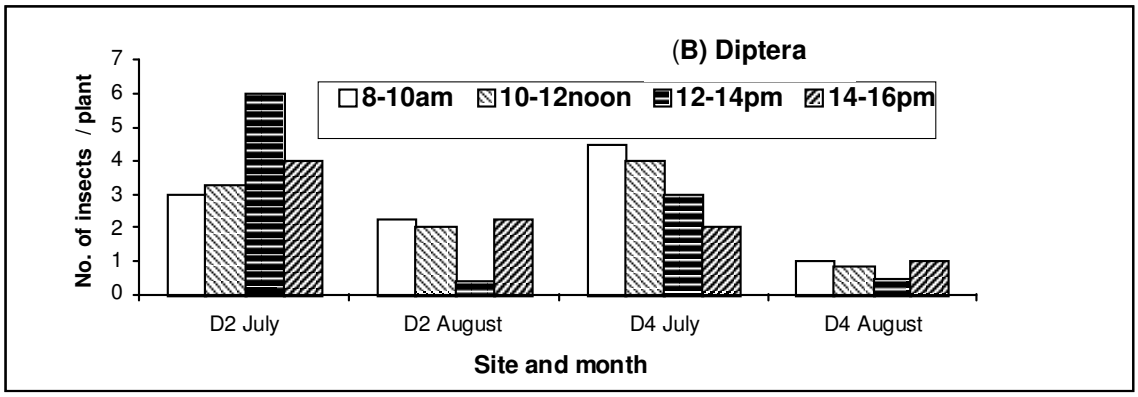
Sixteen variables were observed (4 different insects x 4 different periods) from both study sites. The high eigenvalue observed from the main source of variation among sixteen variables is the first principal component (PRIN1) (Table 2).

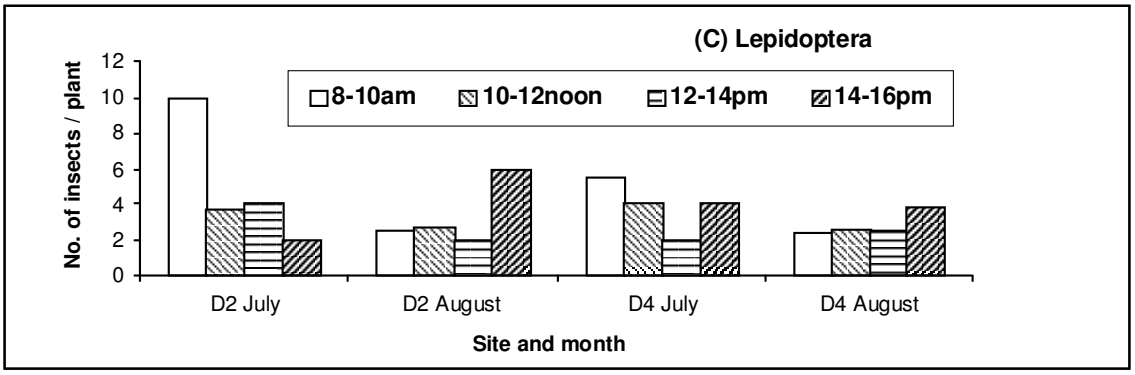
Table (2) Eigenvalues of the Correlation Matrix by Using Principal Component Analysis

	Eigenvalue	Difference	Proportion	Cumulative
PRIN1	5.00580	2.36448	0.312862	0.31286
PRIN2	2.64131	0.43958	0.165082	0.47794
PRIN3	2.20174	0.50793	0.137609	0.61555
PRIN4	1.69381	0.33218	0.105863	0.72142
PRIN5	1.36163	0.36180	0.085102	0.80652
PRIN6	0.99983	0.27537	0.062489	0.86901
PRIN7	0.72446	0.28782	0.045279	0.91429
PRIN8	0.43664	0.06844	0.027290	0.94158
PRIN9	0.36821	0.11966	0.023013	0.96459
PRIN10	0.24855	0.07840	0.015534	0.98012
PRIN11	0.17015	0.08502	0.010634	0.99076
PRIN12	0.08513	0.03385	0.005320	0.99608
PRIN13	0.05128	0.04142	0.003205	0.99928
PRIN14	0.00985	0.00858	0.000616	0.99990
PRIN15	0.00127	0.00094	0.000080	0.99998
PRIN16	0.00034	.	0.000021	1.00000

In general the highest eigenvalue showed that the activity of Hymenopterans visiting teak flowers seems to be highest during 8-10 am. The proportion of the correlation matrix of PRIN1 explained about 31.29% and higher than other components (Table 2). However, equal or larger numbers of Hymenopterans were still visiting flowers during 10-12 hrs (Fig. 2). Data also suggest that more insect visitors were observed in July than in August (Fig. 3 and 4).







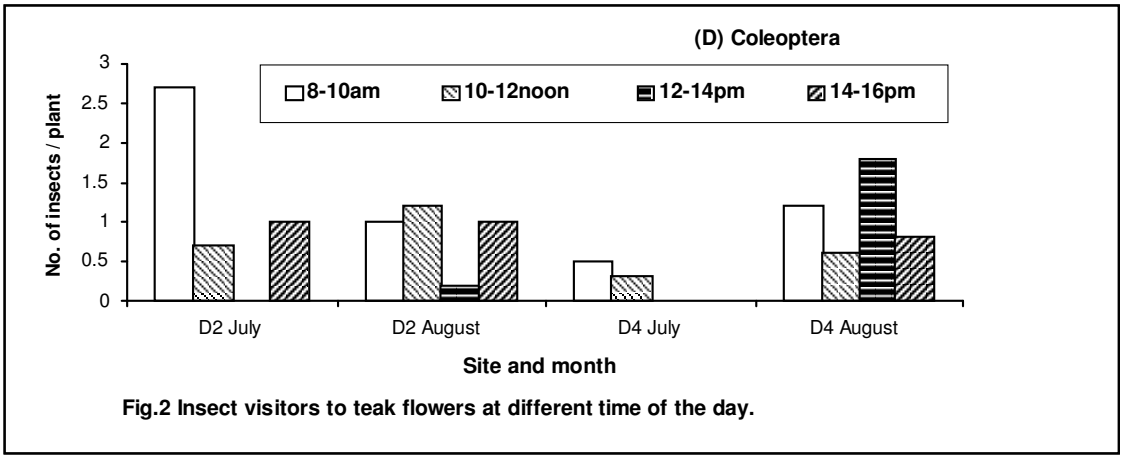


Fig.2 Insect visitors to teak flowers at different time of the day.

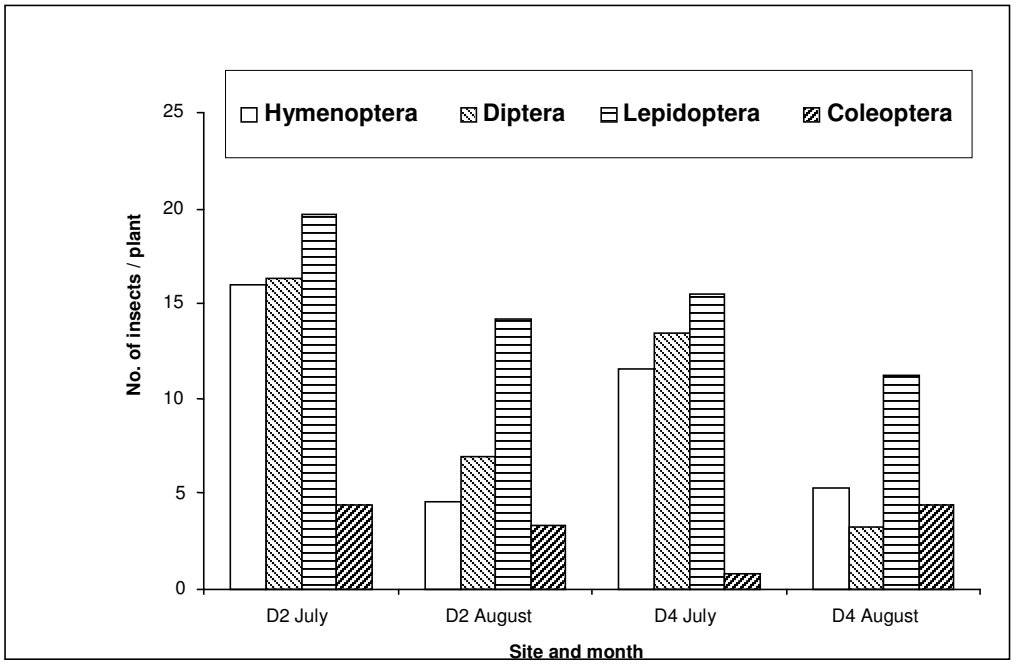


Fig. 3 Insect visitors to teak flowers from 8.00 to 16.00 hour.

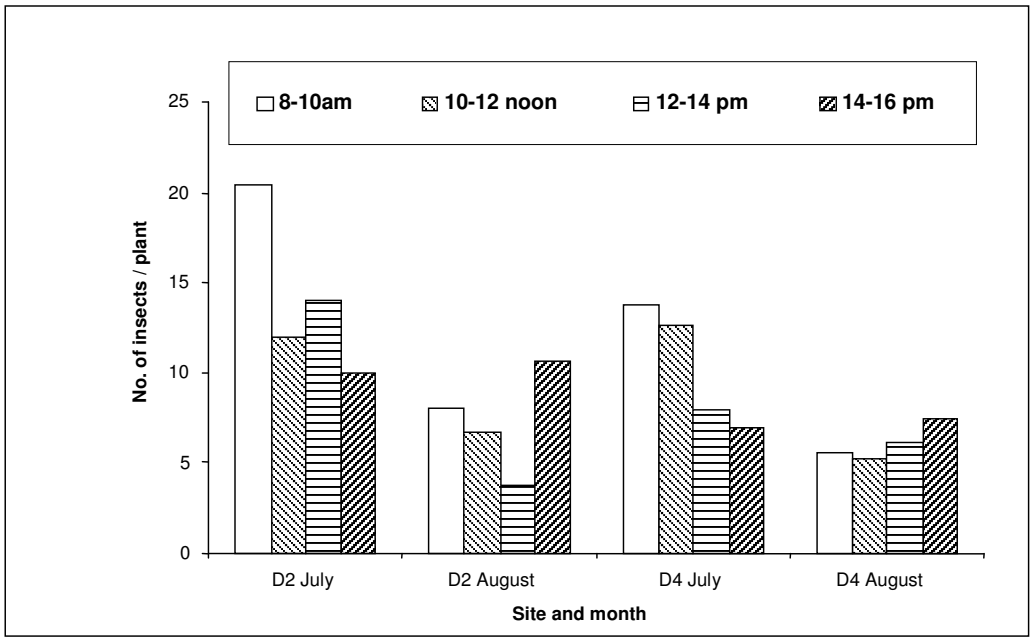


Fig. 4 Insect visitors to teak flowers at different time of the day.

Although the activity of insects was observed to be higher in July than in August, Sampling was started in the last week of July and throughout August. Sampling should be carried out with equal frequency in both months.

Monthly rainfall in July was 32.56" and it was higher than in August (17.01") in 2001. Although lower rainfall (17.77" and 10.86") in July and August, respectively) was recorded in 2002, insect catch in that year was much lower than that of previous year. Data collected in 2002 were excluded from the analysis.

Probability and R^2 values for different insects visiting teak flowers during four periods in two months between two different sites by using Multivariate Analysis of Variance (MANOVA) was shown in table 3. It was not significant on site effects but it was highly significant on different period effect for different insects visiting teak flowers (Table 3).

Table (3) Probability Values for Different Insects Visiting Teak Flowers during four Periods in two Months between two different Sites by Using Multivariate Analysis of Variance (MANOVA).

Different insects	Probability (P > F)		R-square	
	sites	months	sites	months
Hymanoptera	0.989	0.004	0.115	0.872
Diptera	0.901	0.067	0.135	0.731
Lepidoptera	0.665	0.079	0.384	0.718
Coleoptera	0.413	0.598	0.505	0.417

The data obtained from this study suggest that insects were visiting teak flower for the whole day. However, most of the insects were active only at the early hours of the day, i.e. from 8:00-10:00 am. The number of insect visitors decreased with transfer of time. It was true for both sites and in both months observed in this study. More insects were visiting to flowers in June than in August.

Insect visitors from the families of Hymenoptera, Diptera and Lepidoptera were reported to assist the cross-pollination. However, coleopterans insects, such as blister beetles, may be flower eaters. It was found that some species of the order Hymenoptera especially bumble bee (*Bombus* spp.), the small carpenter bee (*Ceratina* spp.), and the carpenter bee (*Xylocopa* spp.) carried pollens (Appendix IV). The pollens were found on the abdomen and on the legs of those insects.

Of the various insects collected the Hymenopterans particularly the anthophorine bees, *Bambus* spp, *Ceratina* spp, *Xylocopa* spp. were the most frequent visitors on teak inflorescence. None of the honey bee species was observed in this

study and this could probably be due to their absence in the vicinity. The possibility of enhancing pollination with the help of honey bee species needs to be explored.

The majority of insects visiting teak flowers are Hymenoptera, Diptera and Lepidotera; and insect activity was highest during the morning (0800 h-1200 h) coinciding with peak pollen presentation and nectar secretion (Mathew, Koshy and Mohanadas 1987 and Egenti 1981). Pollen shedding was the highest from 11:30 to 13:00 hour; it could be much helpful for better pollination and fruit setting if more insect visitors could be attracted to flowers around noon.

In teak, flowering occurs during the rainy season and insect activities on a rainy day are less than on a sunny day. Also, teak stigmas are most receptive at midday (1100 h - 1300 h). High temperature on a sunny day may cause drying of the stigmatic surface resulting in less effective pollination or pollen germination, thus reducing fruit set.

Although it was planned to carry out the collection of insects at weekly intervals at two sites for two months, i.e. in July and August, in 2001 and 2002; the main problem encountered during the study period was the rain. Although the sites were regularly visited, the collection of insects was interrupted many occasions. Insects could be collected only for 3 times in July and for 6 times in August. On many occasions, insect collection could not be done al all intervals as planned.

On some days, although it was not raining, insects were not active enough to visit flowers due to the cloudy conditions. Sunlight and temperature may also have pronounced effect on the activity of insects.

6. RECOMMENDATION

Modification of the environmental factors such as temperature and rainfall is unrealistic under present situation. It is recommended enough to keep artificial beehives at the periphery of the teak plantations. By doing this, pollination of teak flower could be enhanced to some extent and consequently more fruit setting could be expected. On the other hand, income of the employees actively involved in the plantation could also be increased.

7. CONCLUSION

It was found that total number of 31 insect species from 22 Families of four Orders such as Hymenoptera, Lepidoptera, Diptera and Coleoptera were visiting teak flowers during the study period. The data obtained from this study suggest that insects were visiting teak flower for the whole day. However, most of the insects were active only at the early hours of the day, i.e. from 8:00-10:00 am. The number of insect visitors decreased with time. It was true for both sites and in both months observed in this study. More insects were visiting to flowers in July than in August.

Appendix I

Raw data for the insect collection in 2001 at Let-pan khon Clonal Seed Orchard

OBS	FIRST HY	SECOND Hym	THIRD Hym	FOUR Hym	FIRST Dip	SECOND Lp	THIRD Co	FOUR Co	FIRST Lp	SECOND Hym	THIRD Hym	FOUR Co	FIRST Co	SECOND Co	THIRD Co	FOUR Co	SITE	MONTH
1	1	3	0	0	1	2	0	0	8	8	0	0	0	0	0	0	D4	July
2	5	5	3	1	8	7	3	2	3	2	2	4	0	1	0	0	D4	July
3	3	3	0	0	4	2	0	0	1	2	0	0	0	0	0	0	D4	July
4	3	1	0	2	0	1	1	1	2	0	2	0	1	0	1	0	D4	Augu
5	0	0	5	3	1	0	0	1	2	0	2	4	2	0	2	0	D4	Augu
6	0	2	0	2	2	1	0	2	4	4	0	8	1	0	0	3	D4	Augu
7	2	1	0	0	1	1	1	0	4	3	3	3	1	2	1	1	D4	Augu
8	0	2	0	0	0	1	0	0	0	4	3	0	0	0	0	0	D4	Augu
9	0	0	0	0	1	0	0	0	0	2	0	0	1	1	0	0	D4	Augu
10	1	4	0	0	1	2	0	0	15	3	0	0	0	1	0	0	D2	July
11	8	5	4	3	5	2	6	4	10	3	4	2	8	1	0	1	D2	July
12	5	4	0	0	5	2	0	0	5	2	0	0	0	0	0	0	D2	July
13	2	0	2	3	5	7	0	2	7	5	3	10	1	0	0	0	D2	Augu
14	1	0	2	0	0	3	0	2	2	2	0	1	0	2	0	1	D2	Augu
15	2	0	0	1	5	0	0	3	5	2	0	7	2	2	0	2	D2	Augu
16	1	2	1	0	1	0	1	0	2	2	2	0	1	1	1	0	D2	Augu
17	1	2	1	0	1	1	1	0	4	5	5	0	1	1	0	0	D2	Augu
18	1	1	0	0	2	1	0	0	1	0	0	0	1	1	0	0	D2	Augu

FIRST - 8-10 hrs
SECOND - 10-12 hrs
THIRD - 12-14 hrs
FOUR - 14-16 hrs
HY - Hymenoptera
Dip - Diptera
Lp - Lepidoptera
Co - Coleoptera

Appendix II

Number of Insect visitors to teak flowers at different time of a day

Hymenoptera

	8-10am	10-12noon	12-14pm	14-16pm
D2 Block, July	4.7	4.3	4	3
D2 Block, August	1.3	0.8	1.2	1.3
D4 Block, July	3.25	4.3	3	1
D4 Block, August	1	1.2	1.3	1.8

Diptera

	8-10am	10-12noon	12-14pm	14-16pm
D2 Block, July	3	3.3	6	4
D2 Block, August	2.3	2	0.4	2.3
D4 Block, July	4.5	4	3	2
D4 Block, August	1	0.8	0.5	1

Lepidoptera

	8-10am	10-12noon	12-14pm	14-16pm
D2 Block , July	10	3.7	4	2
D2 Block, August	3.5	2.7	2	6
D4 Block, July	5.5	4	2	4
D4 Block, August	2.4	2.6	2.5	3.8

Coleoptera

	8-10am	10-12noon	12-14pm	14-16pm
D2 Block, July	2.7	0.7	0	1
D2 Block, August	1	1.2	0.2	1
D4 Block, July	0.5	0.3	0	0
D4 Block ,August	1.2	0.6	1.8	0.8

Appendix III

Number of Insect visitors to teak flowers at different time of a day

From 8.00 to 16.00 hour

	Hymenoptera	Diptera	Lepidoptera	Coleoptera	Mean	Sd	Total
D2 July	16	16.3	19.7	4.4	14.1	6.680818	56.4
D2 August	4.6	7	14.2	3.4	7.3	4.837355	29.2
D4 July	11.5	13.5	15.5	0.8	10.325	6.556612	41.3
D4 August	5.3	3.3	11.3	4.4	6.075	3.578058	24.3
mean	9.35	10.025	15.175	3.25	9.45	4.883859	37.8
sd	5.410176	5.939346	3.490344	1.7			

All insects

	8-10am	10-12 noon	12-14 pm	14-16 pm	Mean	Sd	Total
D2 July	20.4	12	14	10	14.1	4.506292	56.4
D2 August	8.1	6.7	3.8	10.6	7.3	2.836665	29.2
D4 July	13.75	12.6	8	7	10.3375	3.33501	41.35
D4 August	5.6	5.2	6.1	7.4	6.075	0.956992	24.3
mean	11.9625	9.125	7.975	8.75	9.453125	1.740102	37.8125
sd	6.577408	3.725028	4.368352	1.813836			

Appendix IV

Examples of bumble bee, the small carpenter bee, and carpenter bee.

8. REFERENCES

(1) Beattie, A.J., Turnbull, C., Knox, R.B. and Williams E.G. 1984. Ant Inhibition of Pollen Function: A Possible Reason Why Ant Pollination in Rare. *Amer. J. Bot*. 71(3): 421-426.

(2) Bryndum K, Hedegart T. 1969. Pollination of teak. *Silvae Genetica* 18: 77-80.

(3) Egenti. L.C., 1974. Preliminary studies on pollinators of teak (*Tectona grandis* Linn f.). *Research Paper No. 29.* Research Paper Forest Series, Federal Department of Forest Research, Nigeria.

(4) Egenti. L.C., 1981. Aspects of pollination ecology of teak (*Tectona grandis* Linn f.) in Nigeria. Pollinators and fruit production. In: Krugman SL, Katsuta M, eds. *Proceedings of the symposium on flowering physiology*, IUFRO XVII World Congress, Kyoto, Japan, 27-31.

(5) Hedegart, T. 1973. Pollination of teak (*Tectona grandis* L.) *Silvae Genetica* 22: 124-128.

(6) Hedegart, T. 1976. Breeding Systems, Variation and Genetic improvement of teak (*Tectona grandis* L.) in *Tropical trees, variation, breeding and conservation*, Linnean Society Symposium Series, No.2, (eds.) J. Burley and B.T. Styles, Academic Press, New York, pp. 109-124.

(7) Kaosa-ard, A. 1999. *Teak* (*Tectona grandis* Linn f) *Domestication and Breeding* Teaknet Publication No. 5/1999. UNDP/FAO RAS/91/004

(8) Kermode, C.W.D. 1964. *Some aspects of silviculture in Burma*. Central Press, Yangon, Burma, 53-66.

(9) Maung Gale (2) 1958. Regeneration of teak in Burma. *Proc. All India Teak Study Tour and Symposium*, Dehra Dun, India.

(10) Mathew. G., Koshy. M.P., Mohanadas K. 1987. Preliminary studies on insect visitors to teak (*Tectona grandis* Linn f) inflorescence in Kerala. India, *Indian Forester* 113: 61-64.

(11) Tagmitcharoen,S. and Owens, J.N. 1996. Floral biology, pollination, pistal receptibility and pollen tube growth of teak (*Tectona grandis* Linn f) *Annals of Botany* 79: 227-241.