My Forest – June 2018
Vol. 54 (Issue 2), Page 57-72

MANAGEMENT OF INSECT PESTS IN FOREST NURSERIES FOR PROFITABLE TREE CULTIVATION

John Prasanth Jacob, Nataraj, P., Vadivel, I., Senthilkumar, P. and Senthil, K.

Abstract

Plantation forestry have grown phenomenally during the last couple of decades accelerated by government departments and farmers as a commercial activity by incorporating tree species of commercial and industrial value to meet the needs of local communities by providing fuelwood, fiber and fodder for humans and their cattle. Establishment of tree species varies with different climatic conditions and the demand for such species is on the rise. Forest nurseries are an integral part of plantation programmes as they contribute markedly to forest-regeneration activities. Successful establishment of plantations is dependent on well-managed nurseries which supply quality-planting material. Nursery insect pests generally affect growth and overall health of planting stock, which affect the survival of seedlings transplanted in the field. Development of right pest-management practices is a priority area in forestry to produce healthy seedlings for improved productivity. Timely and proper utilization of the well-designed pest-management practices would keep pests at a manageable threshold and reduce costs of managing pests in outbreak situations. A package of practices for adoption in the management of selected key nursery insect pests of *Albizia lebbeck, Aegle marmelos, Ailanthus excelsa, Azadirachta indica, Mimusops elengi, Phyllanthus emblica, Pongamia pinnata, Syzygium cumini* and *Tectona grandis* is discussed in his paper. Proper integration of different ecofriendly management methods could help in avoiding injudicious and extensive use of chemicals. State Forest Departments, Forest Development Corporations, NGOs and Farmers raising nurseries for plantation purpose are bound to gain by the offered package of practices to manage pest problems in nurseries.

Key words: Nursery, insect pests, management.

Introduction

Forest nurseries are an integral part and contribute significantly towards forest regeneration programme. Successful establishment of plantations is based on the development of a well-managed nursery providing quality planting material. The nursery insect pests are detrimental to the vigorous growth and health of planting stock which ultimately affect the survival of out planted seedlings in the field (Joshi 1994; Ahmad 1994; Varma 1994; Mathew 1994). Development of pest management practices is an important priority area in forestry so as to produce healthy seedlings for attaining improved productivity (Sen Sarma and Thakur, 1986; Joshi, 1994; Nair 1985, 1987). Timely and proper utilization of the developed pest management package of practices could keep the pests at an innocuous level and reduce the high cost of containing the pest in outbreak situations and loss of

Institute of Forest Genetics and Tree Breeding, Coimbatore - 641 002
* jacob@icfre.org

planting material could be avoided. A package of practices to be adopted for management of nursery insect pests is discussed in this paper. Proper integration of various ecofriendly control methods could help to avoid extensive use of chemicals and therefore it will improve the quality of the environment. State Forest Departments, Forest Development Corporations, NGOs and Farmers raising nurseries for plantation purpose will be benefited by the package of practices to manage pest problems in nurseries.

Materials and Methods

Standardization of management practices

Field experiments in Randomized Block Design with various treatments (**Table 1**) and five replications were carried out for the management of selected key pests of *Albizia lebbeck, Aegle marmelos, Ailanthus excelsa, Azadirachta indica, Mimusops elengi, Phyllanthus emblica, Pongamia pinnata, Syzygium cumini,* and *Tectona grandis.* Key pests identified through an earlier study (Jacob, 2008) include Psyllids,

Table 1 – Treatments selected for pest management in forest nurseries

No.	Treatments
1	Tobacco extract (5%)
2	Neem oil emulsion (2%)
3	Neem Seed Kernel Extract (5%)
4	Plant mixture (5%)
5	Pongam oil (2%)
6	Dimethoate (0.06%)
7	Imidacloprid (Confidor) (0.01%)
8	Monocrotophos (0.05%)
9	Microbial formulation – Commercially available microbial formulation of Verticillium lecanii (1%) for sap feeders and Beauveria bassiana (0.6%) formulation for defoliators
10	Mixed bed arrangement- Alternating each nursery bed with beds of different species instead of arranging beds of same species side by side
11	Hand picking
12	Weeding
13	Net collection
14	Gap filling – Filling the space between poly bags with sand
15	Salt lining – Applying common salt crystals on the ground.
16	Gunny bag trapping – Laying wet gunny bag as traps
17	Allowing natural enemy build up

Acizzia indica, Psylla hyaline, Leaf Webing Larva *Rhesala Imparata* and aphids of *Albizia lebbeck;* Citrus Butterfly, *Papilio demoleus* of *Aegle marmelos;* Scale Insect *Megapulvinaria maxima* and Slug *Laevicaulis alte* of *Azadirachta indica;* defoliators *Eligma narcissus* and *Atteva fabricella* of *Ailanthus excelsa* Skipper Larva *Parata alexis* of *Pongamia pinnata;* thrips *Arrhenothrips ramakrishnae* and defoliator *Nephopteryx eugraphella* of *Mimusops elengi;* defoliator *Hyblaea puera* and skeletonizer *Eutectona machaeralis* of *Tectona grandis* besides for miscellaneous pests like *Myllocerus* beetles and grasshoppers. Control beds were maintained without any treatments.

Sprays were given using Knapsack sprayer. Plants were thoroughly sprayed in the evening hours. Surfactant teepol was also added for uniform spreading. In mixed bed arrangement, beds of different tree species were arranged side by side instead of arranging beds of same species side by side. Instead of mass producing and release of natural enemies for biological control, blocks of 50 seedlings with parasites/ predators were covered with close mesh nets to monitor natural enemy build up and compared with insect population level in control. To assess the influence of weeds in building up of common miscellaneous pests like grass hoppers and *Myllocerous* sp. beetles, weeding was regularly done around beds and compared with insect population level in control. Gap between the poly bags were filled with sand and wet gunny bags were spread around beds as well as common salt crystals were applied to manage slug problem in neem. Commercial microbial formulations of *Beauveria bassiana* (Trade name TOXIN) and *Verticillium lecanii* (Trade name SHOCK) were used as microbial agents. Systemic pesticides dimethoate, imidacloprid and contact pesticide monocrotophos were used as insecticides. Plant based extracts were prepared through standard procedures (Vijayalakshmi *et al.,* 2000) and compared with locally available selected, safe commercial pesticides. Mechanical methods like hand picking and net collection of insects were also employed wherever required. Observations on pest population level / percentage damage were made before application of control measures, 10th, 20th and 30th day after application.

Assessment of insect population level, parasitisation and predatory efficiency were carried out based on Jacob (2008). Effect of various management measures were estimated by assessing the significant variation of insect population level/ extent of damaged plants after 10, 20 and 30 days after treatment with the pretreatment level. Similarly, effectiveness of treatments were graded by assessing the significant variation of each treatments with the controls as well as by assessing the mean number of left over insects/ extend of damaged plants or plant parts after 10, 20 and 30 days of treatment. Levels of significance were determined by Dunnett test using KyPlot (Version 2.0 beta 13).

Results

In the present study mixed arrangement of beds did not reduce the incidence of *R. imparata* on *A. lebbeck* after 10th day of treatment. However hand picking significantly reduced the leaf folder population. Spread of the pest tends to get reduced up to 20 days when beds are arranged alternately with bed of other tree species (**Table 2**). When hand picking of *P. demoleus* larvae on *Aegle marmelos* gave sufficient control for 10 days after treatment, the population tends to increase during the 20th and 30th day after treatments. Alternate bed arrangement with other species showed no reduction in the population of *P. demoleus* (**Table 2**). In the

Table 2 – Effect of different treatments on the population of *R. imparata* on *A. lebbeck* and *P. demoleus* on *A. marmelos*

* Number of insects per 50 seedlings. ♣ 0.6% Beauveria bassiana formulation. Mean of 15 observations

**R. imparata on A. lebbeck*						**P. demoleus on A. marmelos*			
Treatments		**Pretreatment**	**Days after treatment**			**Pretreatment**	**Days after treatment**		
			10	**20**	**30**		**10**	**20**	**30**
Tobacco extract	Mean	12.6	7.2	11.4	12.6	2.6	1.2	2.2	2.6
	p		P<0.001	P>0.05	P>0.05		P<0.01	P>0.05	P>0.05
Neem oil emulsion	Mean	11.6	2.8	6.6	11.4	2.6	0.8	1.6	2.2
	p		P<0.001	P<0.01	P>0.05		P<0.01	P>0.05	P>0.05
NSKE	Mean	10.6	7.8	11.6	11.4	2.4	2.6	2.4	1
	p		P>0.05	P>0.05	P>0.05		P>0.05	P>0.05	P<0.01
Plant mixture	Mean	NOT TESTED	2.6	1	2.6	3			
	p			P<0.05	P>0.05	P>0.05			
Pongam oil	Mean	9.8	2.8	4	10.4	2.4	1	1.6	1.6
	p		P<0.001	P<0.001	P>0.05		P<0.05	P>0.05	P>0.05
Dimethoate	Mean	NOT TESTED							
	p								
Imidacloprid	Mean	NOT TESTED							
	p								
Monocrotophos	Mean	10.4	1	1.8	2.2	2	0.4	1	1.4
	p		P<0.001	P<0.001	P<0.001		P<0.05	P>0.05	P>0.05
Microbial ♣	Mean	8.4	1.2	2	2	1.6	1	1	1.2
	p		P<0.001	P<0.001	P<0.001		P>0.05	P>0.05	P>0.05
Mixed bed	Mean	11.2	1.4	12	11.4	1.8	2.2	3	3.2
	p		P<0.001	P>0.05	P>0.05		P>0.05	P>0.05	P<0.05
Hand picking	Mean	9.5	5.0	4.2	6.6	3.2	1.2	1.6	1.8
	p		P<0.001	P<0.01	P<0.001		P<0.05	P>0.05	P>0.05

case of *E. narcissus* on *A. excelsa* alternate bed arrangement with other species were not effective for its control of *E. narcissus* on *A. excelsa* even during the first 10 days after treatment (**Table 3**). To some extent, hand picking was effective in reducing the incidence of *A. fabricella* on *Ailanthus*. Hand picking and removal of galled leaves showed significant reduction in gall incidence in *M. elengi* seedlings up to 30 days after treatment (**Table 4**).

Hand picking of tender leaves with the larva of *P. mathias* from nursery beds of *P. pinnata* was found to be effective only up to 10 days after treatment (**Table 5**). Mechanical control by hand picking of folded leaves besides pesticides significantly reduced defoliator *N. eugrapella* in *M. elengi* up to 30 days after treatment (**Table 5**). Hand picking of tender leaves with the larva of *H. puera* and *E. machaeralis* from teak beds was found to be effective only up to 10 days after treatment (**Table 6**). However, the population tends to increase after the monsoon rains. Alternate bed arrangement with other species did not show reduction in the population of defoliator and skeletoniser on teak. Weeding and net collection significantly reduced the population of common pests like grasshoppers and *Myllocerus* sp. beetles on many of the nursery seedlings up to 30 days after treatment. Filling the gap in between the poly bags with sand and trapping the slugs by spreading wet gunny bags around the beds reduced the damage by *L. alte* on neem seedlings. Slugs usually find shelter in the moist cool places in between the bags or decaying litter. Wet gunny bags attract them. Application of salt crystals around the bed blocks their movement. But it did not reduce the infestation significantly. The mean number of damaged plants in gap filling and gunny bag treatment was significantly low 30 days after treatment **(Table 7).**

Treatments with Tobacco extract, NSKE were not effective against leaf folder *R. imparata* on *A. lebbeck*. Neem and Pongam oil emulsions among plant based extracts gave considerable control of the pest up to 10 days after treatment. *B. bassiana* microbial formulation and insecticide monocrotophos (0.05%) controlled the pest and was effective for 30 days after treatment. In the case of *R. imparata*, plant based extracts tend to be effective up to 10 days after treatment. NSKE showed no effect even up to 10 days after treatm**ent (Table 2**). Tobacco extract, Neem oil and Pungam oil controlled *P. demoleus* up to 10 days after treatment on *A. marmelos*. NSKE and plant mixture extract were not effective against *P. demoleus* (**Table 2**). NSKE, plant mixture extract was not effective for the control of *E. narcissus* on *A. excelsa* even during the first 10 days after treatment. Application of tobacco extract, neem oil emulsion and Pongam oil significantly controlled the pest for almost 20 days after treatment **(Table 3).** Application of plant mixture extract and microbial formulation did not give significant control of the scale insects *M. maxima* on neem. NSKE showed effect only during the first 10 days after treatment. **(Table 4).** Pongam oil, neem oil and tobacco extracts were not effective in bringing down the thrips population in *M. elengi* for up to 10 days after treatment. NSKE tends to be effective up to 20 days after treatment. Among plant based extracts neem oil and Pongam oil significantly reduced defoliator *N. eugraphella* in *M. elengi* up to 30 days after treatment (**Table 5**). Population level of *P. mathias* was significantly brought down by application of Tobacco extract, neem oil and Pongam oil emulsions up to 10 days after treatment. Neem oil and Pongam oil controlled *H. puera* and *E. machaeralis* up to

Table 3 – Effect of different treatments on the population of *E. narcissus* on *A. excelsa* and *A. fabricella* on *A. excelsa*

* Number of insects per 50 seedlings. ♣ 0.6% Beauveria bassiana formulation. Mean of 15 observations

		**E. narcissus on A. excelsa*				**A. fabricella on A. excelsa*			
Treatments		**Pretreatment**	**Days after treatment**			**Pretreatment**	**Days after treatment**		
			10	**20**	**30**		**10**	**20**	**30**
Tobacco extract	Mean	10.2	4.6	6.8	12.4	4.8	2.6	5.8	5.8
	p		P<0.05	P>0.05	P>0.05		P>0.05	P>0.05	P>0.05
Neem oil emulsion	Mean	10.8	3.2	4.2	11.2	4.4	2.6	5	5.2
	p		P<0.001	P<0.001	P>0.05		P<0.05	P>0.05	P>0.05
NSKE	Mean	12.4	11.2	12	13.2	4.6	3	5.4	5.4
	p		P>0.05	P>0.05	P>0.05		P>0.05	P>0.05	P>0.05
Plant mixture	Mean	13.8	9	15.6	18.6	4.6	3.6	6.2	5.6
	p		P>0.05	P>0.05	P>0.05		P>0.05	P>0.05	P>0.05
Pongam oil	Mean	13.4	3.2	5.8	12.8	4.6	2.2	2.8	5
	p		P<0.001	P<0.001	P>0.05		P<0.05	P>0.05	P>0.05
Dimethoate	Mean				NOT TESTED				
	p								
Imidacloprid	Mean				NOT TESTED				
	p								
Monocrotophos	Mean	10.4	0.4	0.8	2.8	3.6	0.2	1.8	1.2
	p		P<0.001	P<0.001	P<0.001		P<0.001	P<0.05	P<0.01
Microbial♣	Mean	10.4	0.8	1.2	10	4	0	2.2	2.2
	p		P<0.001	P<0.001	P>0.05		P<0.001	P<0.05	P<0.05
Mixed bed	Mean	14.2	9.2	18.2	16.6	3.6	3.6	3.8	3.4
	p		P>0.05	P>0.05	P>0.05		P>0.05	P>0.05	P>0.05
Hand picking	Mean	10	1.6	2	2.4	4	1.4	0.8	1.6
	p		P<0.001	P<0.001	P<0.001		P<0.001	P<0.001	P<0.05

Table 4 – Effect of different treatments on the population of Scale on Neem and Thrips on *M. elengi*

* Number of insects per 50 seedlings. ♣ 0.6% Beauveria bassiana formulation. Mean of 15 observations

*		*Scale on Neem*				** Thrips on M. elengi*			
Treatments		**Pretreatment**	**Days after treatment**			**Pretreatment**	**Days after treatment**		
			10	**20**	**30**		**10**	**20**	**30**
Tobacco extract	Mean	35.2	6	9.2	20.6	8.6	3.8	6.8	9.4
	p		P<0.001	P<0.001	P<0.001		P<0.01	P>0.05	P>0.05
Neem oil emulsion	Mean	33.6	2	13.2	23.6	10.4	2.6	8.2	10.6
	p		P<0.001	P<0.001	P<0.05		P<0.001	P>0.05	P>0.05
NSKE	Mean	33.4	21	38.2	33.4	11.6	3.8	6.8	10.4
	p		P<0.05	P>0.05	P>0.05		P<0.001	P<0.01	P>0.05
Plant mixture	Mean	34.4	33.8	36.6	36		NOT TESTED		
	p		P>0.05	P>0.05	P>0.05				
Pongam oil	Mean	35.4	4	17.4	29	9	2.2	6.2	8.8
	p		P<0.001	P<0.001	P>0.05		P<0.01	P>0.05	P>0.05
Dimethoate	Mean	34.8	0	1	10.4	12.6	0.6	1.4	4.6
	p		P<0.001	P<0.001	P<0.001		P<0.001	P<0.001	P<0.001
Imidacloprid	Mean	38.4	0	0	2.4	10.6	0.6	0.8	0.8
	p		P<0.001	P<0.001	P<0.001		P<0.001	P<0.001	P<0.001
Monocrotophos	Mean	38.25	4.25	5.25	18.25	8.6	0.2	1	5.2
	p		P<0.001	P<0.001	P<0.001		P<0.001	P<0.001	P>0.05
Microbial ¥	Mean	32.4	25.4	22	28.6	10.6	0.4	2.6	2.2
	p		P>0.05	P<0.001	P>0.05		P<0.001	P<0.001	P<0.001
Mixed bed	Mean	33	10.2	20.2	36.2	7.8	3.4	5.8	9.2
	p		P<0.001	P<0.01	P>0.05		P<0.05	P>0.05	P>0.05
Hand picking	Mean		NOT TESTED			11	0.8	1.2	0.8
	p						P<0.001	P<0.001	P<0.001

Table 5 – Effect of different treatments on the population of *N. eugraphella* on *M. elengi* and *P. mathias* on Pongamia

* Number of insects per 50 seedlings. ♣ 0.6% Beauveria bassiana formulation. Mean of 15 observations

		*N. eugraphella on M. elengi				* P. mathias on Pongamia			
Treatments		**Pretreatment**	**Days after treatment**			**Pretreatment**	**Days after treatment**		
			10	**20**	**30**		**10**	**20**	**30**
Tobacco extract	Mean	10.6	6.4	11.4	11.8	8.6	4	8.4	9.4
	p		P<0.01	P>0.05	P>0.05		P<0.05	P>0.05	P>0.05
Neem oil emulsion	Mean	7.8	2.8	6.6	9.8	10	2.8	6.6	10.6
	p		P<0.05	P>0.05	P>0.05		P<0.001	P>0.05	P>0.05
NSKE	Mean	10.6	4.8	11.6	11.4	6.2	4.8	11.2	10.6
	p		P<0.01	P>0.05	P>0.05		P>0.05	P<0.01	P<0.05
Plant mixture	Mean	11.2	8.8	11.4	8.2	7	6.8	10.2	10.2
	p		P>0.05	P>0.05	P>0.05		P>0.05	P>0.05	P>0.05
Pongam oil	Mean	8.4	1.6	3.4	5.6	8.4	3.8	3.2	8.6
	p		P<0.001	P<0.001	P>0.05		P<0.05	P<0.05	P>0.05
Dimethoate	Mean			NOT TESTED					
	p								
Imidacloprid	Mean			NOT TESTED					
	p								
Monocrotophos	Mean	12.6	0.4	1	2.6	11.6	0.6	1	2.6
	p		P<0.001	P<0.001	P<0.001		P<0.001	P<0.001	P<0.001
Microbial ♣	Mean	11.6	0.6	3.8	6	10.4	0	2	7
	p		P<0.001	P<0.001	P<0.001		P<0.001	P<0.001	P<0.01
Mixed bed	Mean	9	10.6	7.2	5.8	10.8	6.6	6.4	11.6
	p		P>0.05	P>0.05	P>0.05		P<0.05	P<0.05	P>0.05
Hand picking	Mean	8.6	1.2	2	3.2	10	1.6	5.4	9.6
	p		P<0.001	P<0.001	P<0.01		P<0.01	P>0.05	P>0.05

Table 6 – Effect of different treatments on the population of Common pests and Defoliators on *T. grandis*

* Number of insects per 50 seedlings. ♣ 0.6% Beauveria bassiana formulation. Mean of 15 observations

		**N. eugraphella on M. elen*				** P. mathias on Pongamia*			
Treatments		**Pretreatment**	**Days after treatment**			**Pretreatment**	**Days after treatment**		
			10	**20**	**30**		**10**	**20**	**30**
Tobacco extract	Mean	10.6	6.4	11.4	11.8	8.6	4	8.4	9.4
	p		P<0.01	P>0.05	P>0.05		P<0.05	P>0.05	P>0.05
Neem oil emulsion	Mean	7.8	2.8	6.6	9.8	10	2.8	6.6	10.6
	p		P<0.05	P>0.05	P>0.05		P<0.001	P>0.05	P>0.05
NSKE	Mean	10.6	4.8	11.6	11.4	6.2	4.8	11.2	10.6
	p		P<0.01	P>0.05	P>0.05		P>0.05	P<0.01	P<0.05
Plant mixture	Mean	11.2	8.8	11.4	8.2	7	6.8	10.2	10.2
	p		P>0.05	P>0.05	P>0.05		P>0.05	P>0.05	P>0.05
Pongam oil	Mean	8.4	1.6	3.4	5.6	8.4	3.8	3.2	8.6
	p		P<0.001	P<0.001	P>0.05		P<0.05	P<0.05	P>0.05
Dimethoate	Mean	NOT TESTED							
	p								
Imidacloprid	Mean	NOT TESTED							
	p								
Monocrotophos	Mean	12.6	0.4	1	2.6	11.6	0.6	1	2.6
	p		P<0.001	P<0.001	P<0.001		P<0.001	P<0.001	P<0.001
Microbial ♣	Mean	11.6	0.6	3.8	6	10.4	0	2	7
	p		P<0.001	P<0.001	P<0.001		P<0.001	P<0.001	P<0.01
Mixed bed	Mean	9	10.6	7.2	5.8	10.8	6.6	6.4	11.6
	p		P>0.05	P>0.05	P>0.05		P<0.05	P<0.05	P>0.05
Hand picking	Mean	8.6	1.2	2	3.2	10	1.6	5.4	9.6
	p		P<0.001	P<0.001	P<0.01		P<0.01	P>0.05	P>0.05

Table 7 – Effect of different treatments on the population of Slugs on neem

Number of infested plants per 50 seedlings. Mean of 15 observations

#Slug on Neem					
			Days after treatment		
Treatments		**Pretreatment**	**10**	**20**	**30**
Gap filling	Mean	0	20.4	26	35.6
	p		P<0.001	P<0.001	P<0.001
Salt lining	Mean	0	0.6	3	8
	p		P>0.05	P>0.05	P<0.001
Gunny bag trapping	Mean	0	0	5	11
	p		P>0.05	P>0.05	P<0.01

10 days after treatment on Teak seedlings. NSKE and plant mixture extract were not effective against defoliator and skeletoniser. Application of tobacco extract and NSKE was able to control the grasshoppers and *Myllocerus* sp. population up to 10 days after treatment **(Table 6).**

Insecticide monocrotophos (0.05%) controlled leaf folder *R. imparata* on *A. lebbeck* and was effective for 30 days after treatment. Statistical analysis shows that in spite of the increase in population level of Psyllids and aphids, pesticide treatments were significantly effective up to 20 days after treatment (**Table 8**). Insecticides significantly controlled *E. narcissus* on *A. excelsa* for almost 20 days after treatment (T**able 3**). Monocrotophos was effective in reducing the incidence of *A. fabricella* on *Ailanthus* and the scale population on neem **(Table 3 & 4**). Systemic pesticides significantly reduced the incidence thrips population in *M. elengi* up to 30 days after treatment. Monocrotophos was effective up to 20 days after treatment (**Table 4**). Pesticides gave good control of *H. puera* and *E. machaeralis* on Teak seedlings **(Table 6).**

B. bassiana microbial formulation controlled *R. imparata* on *A. lebbeck* and was effective for 30 days after treatment. Though not highly significant, population reduction of the pest by natural enemies was evident after 20 days of treatment **(Table 2).** Population of *P. demoleus* increased during the first 10 days of when left with natural enemies to build up. After 20 days of treatment there was a clear reduction in the unparasitised larvae **(Table 2)**. Natural enemies of microbial formulations were effective in reducing the incidence of *A. fabricella* on Ailanthus **(Table 3).**

Microbial formulation of *B. bassiana* and insecticides significantly controlled *E. narcissus* on *A. excelsa* for almost 20 days after treatment (**Table 3**). Microbial formulation did not give significant control of the scale insects on neem. However a reduction in population was observed after 20 days of microbial treatment. In the case of thrips population in *M. elengi*, microbial formulation significantly reduced the incidence up to 30 days after treatment.

Discussion

Increased rate of tree planting is felt very much needful nowadays to reclaim wastelands and to arrest further ecological degradation besides to meet the needs of local communities by providing fuelwood and fodder for man and his cattle. Thus plantation forestry have grown phenomenally, accelerated by government departments and farmers as a commercial activity incorporating tree species of high commercial and industrial value. Pest management in forest nurseries relies mostly on monitoring to detect pest incidences and identify pest population levels. The key tactic is prevention (Mathew 1994a). Repeated surveillance has been advised to detect insect incidence and its increase beyond a certain level in the planting stock (Bhandari and Singh 1988). Nair *et al* (2004) suggested a solar basket light trap as an efficient devise for monitoring population trends of chosen species. A number of major groups of moths, beetles, bugs, and grasshopper are attracted to light traps. Khan et al (1988) studied the seasonal activity and abundance of 15 insect species of agro forestry importance by light trap.

Roonwal (1990) reports that mechanical methods are feasible where labor is relatively cheap. Caterpillar of *Ailanthus* i.e. *Eligma narcissus* was handpicked and killed by dropping in a tin with mixture of kerosene and water. Pupal cluster scrapped of the trunk and killed by crushing with stone. Large number of pupae can be killed and population following generation is greatly reduced. Behavior of pests can be identified and management measures can be directed in such a way that it can be utilized to direct, trap or kill the organism in the present study management of slugs in neem seedlings was successful by identifying the behavior of slugs. Behavior of rebuilding the nest cover has been made use to kill sapling borer *Sahyadrassus malabaricus* in Teak (Nair 1986).

Tobacco extract, neem oil and Pongam oil emulsions were found to be effective in the present study against skipper butterfly larva, teak defoliator, grass hoppers and *Myllocerus* .sp beetles on seedlings. Presence of insecticidal properties of many plant extract has been already established (Ahmad *et al.,* 1996). NSKE 5% and neem based insecticide was find to be effective agent *Helicovexin armigera* and *Diacrisia obligua* (Deole et al., 2003) and the same was reported to influence nutrition and reproduction of *Taragama siva* (Sundararaj *et al.,* 1995). Various botanical insecticides has been used to manage pest like *Aphis gossipii*, *Myzus persicae*, *Spodoptera litura* on agricultural crops (Devi *et al.,* 2003, Sagar 1992 Singh *et al.,* 1995 Singh and Rao 2000). Extract of *Calotropis procera*, *Datura metal* and *Azadirachta indica* were effective agent *E. machaeralis* (Meshram, 1995) and *Holigarna arnottiana* against *H. purea* (Ramana *et al.,* 2004). Extract of *Adhatodha vasica*, *Pongamia pinnata* and neem were used to control termites (Das and Chattopadhyay 2003). Aqueous extract of *Adhatoda vasica* was found to have insecticidal property against *Rhesala imperata* on *Albizia lebbeck* (Srivasta *et al.,* 1996) Similarly *Cinnamomum camphora* oil tends to deter feeding by defoliators on *Gmelina arborea* (Pandey *et al.,* 1997).

Reduviis bugs like *Panthous bimaculatus* has been reported as a predator thriving on defoliator of *Ailanthus* and making it an ideal biocontrol agent (Varma 1989). Swarms of dragonfly *Pantala flavescens* predates on psyllids on subabul and was reported to have detectable impact on the numbers of the

Table 8 – Effect of different treatments on the population of Psyllids and Aphids on *A. lebbeck*

* Number of infested plants per 50 seedlings. ¥ 1% *Verticillium* lecanii formulation. Mean of 15 observations

# Psyllids on *A. lebbeck*						# Aphids on *A. lebbeck*			
			Days after treatment				**Days after treatment**		
Treatments		**Pretreatment**	**10**	**20**	**30**	**Pretreatment**	**10**	**20**	**30**
Tobacco extract	Mean	33.2	3.6	9	14.8	35.8	7.4	9.6	18
	p		P<0.001	P<0.001	P<0.001		P<0.001	P<0.001	P<0.001
Neem oil emulsion	Mean	36.4	2.4	9.8	14.2	38.2	3	12.8	21.2
	p		P<0.001	P<0.001	P<0.001		P<0.001	P<0.001	P<0.001
NSKE	Mean	38	4.2	15.8	20.2	46.6	15.6	20.4	24.8
	p		P<0.001	P<0.001	P<0.001		P<0.001	P<0.001	P<0.001
Plant mixture	Mean	35.4	3	23.2	30.2	38	20.2	32.8	39
	p		P<0.001	P<=0.01	P>0.05		P<0.001	P>0.05	P>0.05
Pongam oil	Mean	34	2.4	9.4	17.2	38.6	3.6	10	29.4
	p		P<0.001	P<0.001	P<0.001		P<0.001	P<0.001	P<0.001
Dimethoate	Mean	35.6	0	9	12.8	46.8	0	0	3
	p		P<0.001	P<0.001	P<0.001		P<0.001	P<0.001	P<0.001
Imidacloprid	Mean	36.4	0	0	0	42.4	0	0	0.6
	p		P<0.001	P<0.001	P<0.001		P<0.001	P<0.001	P<0.001
Monocrotophos	Mean	38	0.2	0.6	4.6	43	0.6	0	9
	p		P<0.001	P<0.001	P<0.001		P<0.001	P<0.001	P<0.001
Microbial ¥	Mean	33.8	0.6	6.2	18.2	40.6	3	5.4	18.8
	p		P<0.001	P<0.001	P<0.001		P<0.001	P<0.001	P<0.001
Mixed bed	Mean	37.6	12.2	21.2	27	44	9.8	35.6	44.4
	p		P<0.001	P<0.001	P<=0.01		P<0.001	P>0.05	P>0.05
Natural enemy	Mean	38.2	35.5	29.4	35	32.4	29.9.4	20.4	35.6
build up	p		P>0.05	P<0.001	P>0.05		P>0.05	P<0.001	P>0.05
Hand picking	Mean	NOT TESTED							
	p								

pest (Joseph and venkitation 1995). Teak skeletenizer *E. machaeralis* has a natural enemy complex of 43 species of parasitoids and 60 species of predator. These bio control agents can be sustained by delaying or avoiding pesticide application. (Patil and Thontadarya 1983). 25-38% reduction in the population of bagworm *Pteroroma plagiophleps* was reached due to parasitism by *Goryphus* sp. (Chalcididae) (Mathew 1989). Braconid *Apanteles papilionis* and *B. hebetor* were reported to be associated with larval populations of *P. demoleus* during peak periods of pest activity (Lakshmi Narayanan *et al.,* 2003). Among the naturally occurring ant species occur in the nursery environment, *Anoplepis longipes* showed high predatory potential against *A. indica* psyllid on *A. lebbeck* Rajendran *et al.,* 2000). Delaying pesticide sprays will also help in incidence of natural epizootics. Natural epizootics of polyhedrosis virus are reported to control defoliator *Taragama Siva* on *Prosopis julifera* (Ahmed and Kumar 1998). *Beauveria bassiana* is a virulent microbial pathogen of *A. fabriciella* of Ailanthus (Mohammed and Varma 1994). Spraying of *Bacillus thuringieusis* on Ailanthus plants was effective agent *A. fabriciella* Joshi *et al.,* 1996). Commercially available microbial insecticides have been reported to be effective agent teak skeletenizer also (Meshram *et al.,* 1997).

Nephopteryx eugraphella on sapota was controlled by chemical pesticide like permithrin (0.01%) Fenvalerate (0.01%) monocrotophos 0.03% (Jhala *et al.,* 1993). Monocrotophos was found to be effective agent *A. fabriciella* in Ailanthus (Meshram and Jamaludin 1989). Rajendran *et al.* (2001) also showed that synthetic insecticidal were superior to botanical in controlling psyllids in Albizia in nurseries.

Conclusion

In spite of the best efforts made nurseries experience losses due to insect pest damage. Such field losses are due to improper management of pest problems while seedlings are in nurseries. Nursery managers must analyze the damage or losses caused by insects and the costs involved in preventing such pest problems. For profitable tree cultivation production of quality planting materials in forest nurseries is very much required and feasible management measures as identified in the present study can be deployed against insects to avoid pest problems assuming serious proportions resulting in partial or total loss of planting material.

References

Ahmed, M., Dayal, R and Borai, P. (1996). Evaluation of insecticidal properties of *Dalbergia stipulacea* against poplar defoliator, *Clostera cupreata* (Lepidoptera: Notodontidae). ***Annals of Forestry***, 4: 47–51.

Ahmed, S.I and Shivesh Kumar (1998). Role of natural epizootics of a NPV disease in controlling *Prosopis juliflora* defoliator *Taragama siva* outbreak in North-West Rajasthan. ***Indian Forester,*** 124: 952–957.

Ahmed, S.I. (1994). Pest of Neem and their management in arid and Semi-arid region. In *Forest Entomology* Edited by L.K. Jha and P.K. Sen sarma, pp. 51–80.

Bhandari, R.S. and Singh Pratap (1988). Epidemic of sal heart-wood *Hoplocrambyx spinicornis* newm. (Coleoptera: Cerambycidae) and its Control in Pachmari, Madhya Pradesh. ***Indian Forester***, 114: 152–157.

Das Nilanjana and Chattopadhyay, R.N. (2003). Control of Termites through application of some Phyto-Extracts – a new approach in forestry. ***Indian Forester***, 129: 1538–1540.

Deole Sandnya, Jayant Gadpayle, Prasad Burange and T.P. Rajendran (2003). Comparative evaluation of botanical and bioagent formulations Against Helicoverpa armigera hubner in Chickpea Crop under Central Indian Conditions. ***Pestology,*** 27: 19–21.

Devi Nonita, M., Singh, T.K. and Chitra Devi, L. (2003). Efficacy of certain botanical insecticides against cotton aphid, *Aphis gossypii* Glover on Brinjal. ***Pestology,*** 27: 6–10.

Jacob J.P. (2008) Foresters Manual on nursery Pests and Their Management. *ICFRE Publication*, Coimbatore, pp 60.

Jhala, R.C., Patel, Z.P., Patel, K.G., Patel, M.B and Patel, C.B (1993). Chemical control of bud boring insects, *Anarsia achrasella* Bradley and *Nephopteryx eugraphella* rangonot on sapota.***International Pest Control,*** 35: 75–77.

Joseph, K.J. and Venkitesan, T.S. (1995). Predation of the Subabul Psyllid *Heteropsylla cubana* by the dragonfly *Pantala flavescens* in nature. ***Entomon,*** 20: 273–275.

Joshi, K.C. (1994). Pests of Acacia sp. and their management. In *Forest Entomology,* Edited by L.K. Jha and P.K. Sen Sarma, pp. 23–49.

Joshi, K.C., Roychoudhury, N., Sumbath, S., Humane, S and Pandey, D.K. (1996). Efficacy of three varietal toxins of *Bacillus thuringiensis* against *Ailanthus* defoliator, *Atteva fabriciella* swed. (Lepidoptera: Yponomeutidae). ***Indian Forester,*** 122: 1023-1027.

K.S.S. Nair (1986). Control of the sapling borer, *Sahradrassus malabarticus* (Lepidoptera, Hepialidae) in forest plantations. ***Entomon,*** 12: 137–39.

Khan, H.R., Sushil Kumar and Lalji Prasad (1988). Studies on seasonal activity of some agro forestry insect pests by light trap. ***Indian Forester,*** 114: 215–229.

Lakshmi Narayanakumar, V., Savitha, P. and Ramakrishna Rao (2003). Natural enemies and percent parasitisation of Citrus butterfly, *Papilio demoleus* on sweet orange and acid lime. ***Indian Journal of Entomology.*** 65: 461–464.

Mathew George (1989). Natural enemies of the bagwarm, *Pteroma plagiophles* hampson (Lepidoptera: psychidae) in Kerala (India). ***Entomon,*** 14: 335–338.

Mathew, G. (1994). Pests of *Casuarina equisetifolia* and their management. In *Forest Entomology* Edited by L.K. Jha and P.K. Sen Sarma, pp. 187–194.

Meshram, P.B. (1995). Evaluation of some medicinal and natural plant extracts against teak skeletonizer, *Eutectona machaeralis* walk. ***Indian Forester,*** 121: 528–531.

Meshram, P.B. and Jamaluddin (1989). Efficacy of Monocrotophos against Ailanthus Webwarm, *Atteva fabriciella* swed. (Lepidoptera: Yponomeutidae). ***Indian Forester,*** 115: 113–116.

Meshram, P.B. *et al* (1997). Efficacy of bioasp- a microbial insecticide against teak skeletenizer, *Eutectona mechaeralis* walk**.** ***Indian Forester,*** 123: 1202–1204.

Mohamed Ali, M.I. and Varma, R.V. (1994). *Beauveria bassuana*- A new insect pathogen on *Atteva fabriciella* and its comparative efficacy with *Paecilomyces farinosus.* ***Entomon,*** 19:153–157.

Nair, K.S.S. (1985). Role of behavioral studies in the development of management strategies for forest insect pests. ***Proceedings of Indian Academy of Sciences,*** (Anim. Sci.) 94: 341–350.

Nair, K.S.S. (1987). Control of sapling borer, *Sahyadrassus malabaricus* in forest plantations. ***Entomon.*** 12: 137–139.

Nair, K.S.S., Sudeendrakumar, V.V., Sanjeev, T.V., Gearge Methew, Varma, R.V and Sivadas, T. (2004). A solar trap for monitoring forest insect populations. ***Entomon,*** 29: 111–117.

Pandey Ashok K., J. Prasanth Jacob., Das, D.K. and Sharma, P.C. (1997). Insect feeding deterrency *Cinnamomum camphora* Oil against two Defoliators of *Gmelina arborea* Roxb. (Verbenaceae). ***Indian Journal of Forestry,*** 20: 98–100.

Patil, B.V. and Thontadarya, T.S. (1983). Natural enemy complex of the teak Skeletenizer, *Pyrausta machaeralis* walker (Lepidoptera: Pyralidae) in Karnataka. ***Entomon,*** 8: 249–255.

Prasad Lalji (2003). *Chrysopherla carnea* Stephens (Neuroptera : Chrysopidae) as a new predator of *Plecoptera reflexa* Guen. A key defoliator of Shisham. ***Indian Forester,*** 129: 1415–1417.

Pratap Singh and Ram Mohan Mishra (1988). new records of predators of the *Meliaceae* shoot borer *Hypsipyla robusta* Moore (Lepidoptera: Pyralidae). ***Indian Forester,*** 114: 399–404.

Rajendran, P., Thirumurthi, S. and Divakara, B.N. (2000). Evoluation of the efficiency of certain biocontrol agents against *acizzia indica* (Heslop-Harrison) (Psyllidae: Homoptera) on *Albizia lebbeck* (L.) benth. ***My Forest,*** 36: 207–219.

Rajendran, P., Thirumurthi, S. and Divakara, B.N. (2001). Insecticidal control of *Acizzia indica* (Heslop-Harrison) (Psyllidae: Homoptera) on *Albizia lebbeck* (L.) benth. ***Indian Journal of Forestry,*** 24: 332–336.

Ramana, P., Patil, S.K. and Rao, K.S. (2004). Anti feedant activity of *Holigarna arnottiana* against larvae of teak defoliator, *Hyblea puera*. ***Journal of non-Timber Forest Products***, 11: 158–160.

Roonwal, M.L. (1990). Field-Ecological observations on the *Ailanthus excelsa* defoliator, *Eligma narcissus Indica* (Lepidoptera, Noctuidae), in peninsular India. ***Indian Journal of Forestry,*** Vol. 13: 81–84.

Sagar, P. (1992). Efficacy of insecticides against the aphid, *Aphis gossypii* Glover on Isabgol, *Plantago ovata* Forsk in the Punjab. ***Indian Journal of Entomology,*** 54: 399–401.

Sen Sarma, P.K. and Thakur, M.L. (1986). Termite problems in plantation crops and their management in oriental region. ***Journal of Indian Academy of Wood Sciences*** 16: 99–108.

Singh, M.P., Khuman, M.S. and Salam, J.S. (1995). Efficacy of certain plant extracts against *Mysus persicae* Sulzer (Homoptera: Aphididae) on cabbage in Manipur. ***Indian Journal of Plant Protection***., 23: 139–141.

Singh, S. and Rao, P.J. (2000). Effect of Ageratum conyzoides on development and reproduction of *Spodoptera litura*. ***Indian Journal of Entomology***, 62: 231–238.

Srivastav Anubha., Vishaka kumbhara., Pandey, D.K. and Sadhana Srivastav (1996). Preliminary phytochemical and insecticidal studies of leaf exract of *Adhatodha vasica* on *Albizia lebbeck* defoliator, *Rhesala imparata* wak. (Lepidoptera: Noctuidae). ***Indian Journal of Forestry,*** 19: 83–86.

Sudeenndrakumar, V.V. (1993). Notes on hymenopteran parasites of Ectectona mechaeralis recorded from Nilambur, Kerala. ***Indian Forester***, 119: 510–511.

Sundararaj, R., Murugesan, S., Ahmed, S.I. (1995). Differential impact of NSKP extracts on nutrition and reproduction of *Taragama siva* lefbvre (Lepidoptera: Lasiocampidae). ***Entomon,*** 20: 257–261.

Varma, R.V. (1989). New record of *Panthous bimaculatus* (Hemipera: Reduviidae) as a predator of pest of *Ailanthus triphysa*. ***Entomon,*** 14: 357–358.

Varma, R.V. (1994). Insect pests of Albizia spp. and their management. In: *Forest Entomology***.** Jha, L.K., Sen Sarma, P.K. (Eds.) 242–250.

Vijayalakshmi, K., Subhashini, B. and Shivani Koul (2000). Plants in pest control pongam, Tulsi and Aloe. Published by ***Centre for Indian Knowledge System***, Chennai, pp. 33.