Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

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Occurrence of forest nursery pests in moist decidous forest ecosystem at Kodagu, Karnataka

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Abstract
The observations on the occurrence of forest nursery pests at College of Forestry Nursery, Ponnampet from August 2019 to April 2020 indicated that, *Garcinia gummi-gutta*, *G. indica* and *Syzygium cumini* were majorly infested with pink scales, whiteflies and mealybugs. Chysomelid beetle, *Podontia congregata*, and a leaf miner; *P. congregata*, *Busoniomimus manjunathi*; Aphids and cow bugs were the insects observed at low level on *G. gummi-gutta*, *G. indica* and *Albizzia lebbeck*, respectively. *Sapindus emarginatus* recorded the occurrence of a Myllocerous weevil at a lower (0.50 to 6.50) percentage. The incidence of major insects on *G. gummi-gutta*, *G. indica* and *S. cumini* showed a positive correlation with temperature and negative correlation with RH and Rainfall; with significant and non-significant differences.

Keywords: occurrence, forest nursery pests, moist decidous forest ecosystem

1. Introduction
The infestation and loss caused by forest nursery pests has been reported to the extent of 30 to 100 per cent depending on the host and the insect pest species. Perusal of the reports on forest nursery pests in India [1-3] indicates that the extent of damage varies depending on the region, species of host plants and the insect pests. This necessitates the survey and documentation of insect pest occurrence, periodicity of their infestation, intensity of damage caused by them and also the impact of prevailing weather factors on insect pest build up. When this kind of information is available for all the seedlings that are raised in the nursery, they can be very well utilized in devising effective pest control modules. Timely and proper utilization of suitable pest management strategy will keep the pest below the economic injury level and there by the vigorous growth and health of planting stock may be maintained. Thus, the present study was undertaken to document the occurrence of forest nursery pests at College of Forestry Nursery, Ponnampet on selected forest seedlings.

2. Materials and Methods
The observations were recorded on the occurrence of insect pests from August 2019 to April 2020 at College of Forestry Nursery, Ponnampet, on five plant species, which were raised in large numbers, i.e., *Garcinia gummi-gutta, G. indica, Syzygium cumini, Albizzia lebbeck* and *Sapindus emarginatus.*
The observations, were made in the seedlings raised in the nursery. The plants were of one years of age, and they were maintained in poly bags of size 5" and 8". The seedlings were arranged in blocks of 1m x 20m. In each block, a sub-block of 50 number of seedlings was selected by replicating four times. Thus, a total of 200 plants of each species, were observed for the occurrence of insect pests at fortnightly intervals. For each of the species under observation, all the four sub blocks from the main block with 50 seedlings were selected randomly at every time of observation.

2.1 Insect pest occurrence
Species wise, the seedlings were observed for the presence of insect pests and even the seedlings without the presence of insect pests but with typical symptoms of the insect damage, were also taken into account as infested ones.

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2.2 Intensity of damage

The intensity of damage was worked out by taking into account the number of infested seedlings in a selected sub block of 50 seedlings, by using the following formula.

$$\text{Per cent incidence} = \frac{\text{Number of seedlings affected}}{\text{Total number of seedlings in a sub block}} \times 100$$

2.3 Categorisation of insect pests

Based on the intensity of occurrence (per cent seedling infested by insects among the 50 number of seedlings observed) the pests were categorised as major, minor and negligible pest [4]. The details of the categorisation of insect pests have been presented in Table -1

The correlation coefficient between the insect pests occurrence and prevailing weather parameters was worked out only in respect of minor and major insect pests i.e., in case of insects which recorded the infestation level of 12 per cent and above.

Table 1: Criteria used for categorisation of insect pests occurred on forest nursery seedlings.

Sl. No.	No. of seedling infested / 50 seedlings	Percent infestation	Level of infestation	Categorisation of insect pest
1	<6	<12	Low	Negligible
2	6-12	12-24	Medium	Minor
3	>12	>24	High	Major

2.4 Development of insect pest calendars

Insect pest calendar depicting the level of incidence (as low, medium and high) of each species of insect pest observed on each selected species of forest seedlings was also developed. The incidence level of an insect for a particular month was decided by taking the mean values of per cent incidence of that insect in two fortnightly periods of the month.

2.5 Data analysis

The per cent incidence of the insect pests was correlated with the prevailing weather parameters. The mean fortnightly weather parameters such as Minimum temperature, Maximum temperature, Minimum RH, Maximum RH and Rainfall from the Agricultural and Horticultural Research Station, Ponnampet.

The parameters prevailing in the preceding fortnight of the day of observation were taken into account for working out the correlation.

Correlation was calculated by using the following formulae as suggested by Gomez and Gomez, 1984 [5].

$$r = \frac{N\sum xy - (\sum x)(\sum y)}{\sqrt{N\sum x^2 - \left[(\sum x)^2 (\sum y)^2\right] - (\sum y)^2}}$$

Where,
N = No. of observations
$\sum x$ = Summation of Individual weather parameters
$\sum y$ = Sum of all observations in Individual insect parameters
$\sum x^2$ = Sum of square of x scores
$\sum y^2$ = Sum of square of y scores

3. Results and Discussion

The important insect pests observed at College of Forestry nursery were Pink scale *Ceroplastes rubens,* Chrysomelid beetle *Podontia congregata* on *Garcinia gummi-gutta*, *G. indica*; Additionally *G. gummi-gutta* had the infestation by leaf miner and *G. indica* by a leafhopper (Table 2). In a similar study [1], the nursery pest problems on some native tree species in Kerala had recorded the occurrence of leafhoppers and leaf miners in *G. gummi gutta* and *G. indica.* The occurrence of *P.congregata* on *Garcinia* sp. was reported from Western Ghats region [6].

On *S. cumini*, two sap sucking pests, whitefly and a mealybug were reported in the present investigation (Table 2). But, in a study as many as 78 species of insect pests on *S. cumini* mainly belonging to Lepidoptera and Hemiptera orders were recorded [7]. The higher number of insect pest recorded by them can be because of the fact that, survey by them was carried out in forest areas not restricting to forest nurseries as it was in the present study.

Albizzia lebbeck seedlings were found infested with two sucking pests, the aphids and cow bugs (Table 2). Similarly, two sucking pests on *A. lebbeck, Psylla hyallne* and *P. oblonga* in addition to a pierid caterpillar was recorded [8].

The seedlings of *S. emarginatus* were found defoliated by a weevil, *Myllocerous discolour* (Table 2). Irrespective of the host plants, the insect pests recorded at Ponnampet nursery comprised of 64 per cent sapsuckers, 27 per cent leaf feeders and nine per cent leaf miners, from the orders of Hemiptera (7 species), Coleoptera (3 species) and Lepidoptera (1 species) (Fig. 1 and 2). These observations are in conformity with the findings of a study who also recorded the dominance of sap-sucking and defoliating insects in forest nursery at Peechi, Kerala [1].

The seasonal incidence of pink scale on *G. gummi-gutta* varied from 4 – 25.50 per cent during the observational period. There was a steady increase in the infestation level from August first fortnight (6.0%) to a peak of 25.50 per cent by December first fortnight. Then onwards it gradually declined and reached the lowest of 4.00 per cent by second fortnight of April. In case of *G. indica*, the same insect reached its peak by first fortnight of February and then onwards began to decline (Table 3). However, in both the species, the occurrence of the pest was observed during the entire observational period. Ecological studies on *C. floridensis* also revealed the occurrence of pest throughout the year, but with four peaks during February, May, July and October [9]. On the contrary, in the present investigation, peak incidence was observed in both the species of host plants only once. This difference can be attributed to the differences in the species under study and also the number of life cycles per year the species of insects having.

The correlations between weather factors and the insect incidence in case of

G. gummi-gutta was non-significant; negatively with Maximum temperature, Minimum and Maximum RH and Rainfall, and positively with Minimum temperature, whereas in case of

G. indica it showed a significant positive relationship with Minimum temperature and significant negative relationship with Maximum temperature, Minimum RH, Maximum RH and Rainfall (Table 4). These findings are narrowly agreeing

with the results of a study [9] which recorded the positive significant and non-significant (at different years) relationship with temperature and non significant negative correlation with RH in respect to the occurrence of *C. foridensis*.

The whitefly incidence on *S. cumini* was observed throughout the observational period with the infestation level ranging from 4.50 to 26.50 per cent. From first fortnight of August to second fortnight of October, the pest was in lower intensity (4.50 to 11 %), from first fortnight of November to first fortnight of January and again from first fortnight of March to second fortnight of April the intensity was at medium level (12.00 to 18.50 %), and from January second fortnight to February second fortnight, it was at higher level (25.5 to

26.00 %). In earlier studies on seasonal incidence of whiteflies, though showed their presence throughout the year, there were contradictions about their peak periods of incidence

(Table 7). The maximum incidence from the second week of March to the third week of March (*Bemisia tabaci*) [10], and maximum population of spiralling whitefly during January [11] was recorded in earlier studies. Perusal of the present findings and that of earlier studies indicated that the peak period of occurrence of whiteflies varies with the species under observation and hence there is no similarity in the present observations and that of earlier reports.

Table 2: Insect pests recorded at College of Forestry nursery, Ponnampet

Host plant		Insect pest	Nature of damage	Intensity of infestation
Garcinia gummi-gutta	1	Pink scale *Ceroplastes rubens* (Coccidae: Hemiptera)	Sap sucking	Medium to high
	2	Chrysomellid beetle *Podontia congregate* (Chrysomelidae: Coleoptera)	Leaf feeding	Low
	3	Leaf miner (Lepidoptera)	Leaf mining	Low
Garcinia indica	4	Pink scale *Ceroplastes rubens* (Coccidae: Hemiptera)	Sap sucking	Medium to high
	5	Chrysomellid beetle *Podontia congregate* (Chrysomelidae: Coleoptera)	Leaf feedling	Low
	6	Leafhopper *Busoniomimus manjunathi* (Cicadellidae:Hemiptera)	Sap sucking	Low
Syzygium cumini	7	Whitefly *Rusostigma Eugenie* (Aleyrodidae: Hemiptera)	Sap sucking	Medium to high
	8	Mealy bugs (Hemiptera)	Sap sucking	Medium to high
Albizzia lebbeck	9	Aphids (Aphidae: Hemiptera)	Sap sucking	Low
	10	Cow bug *Oxyrachis tarandus* (Membracidae: Hemiptera)	Sap sucking	Low
Sapindus emarginatus	11	Myllocerous weevil *Myllocerous discolour* (Curculionidae: Coleoptera)	Leaf feeding	Low

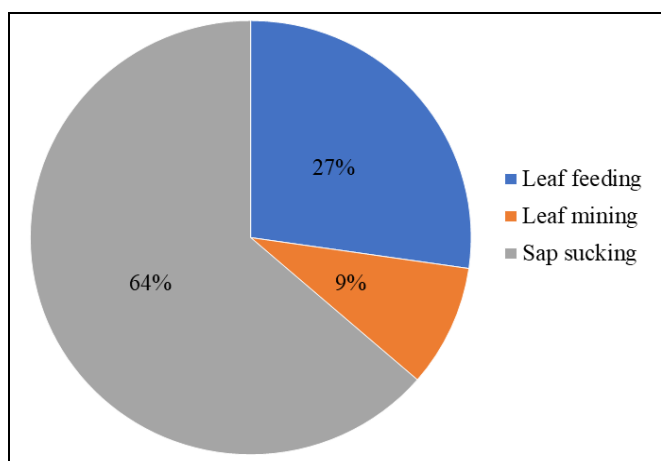**Fig 1:** Relative proportion of insect pests as per their nature of damage at College of Forestry nursery, Ponnampet
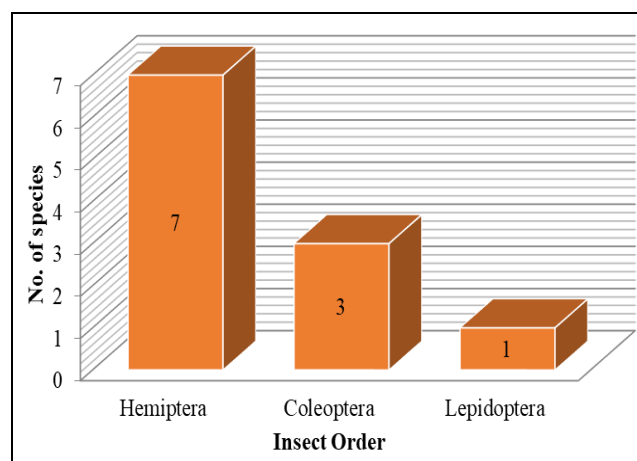

Fig 2: Order wise occurrence of insect pests at College of Forestry nursery, Ponnampet

Table 3: Seasonal incidence of insect pests with medium to high level of infestation at College of Forestry nursery, Ponnampet

Fortnights	Incidence of insect pests (Percentage of plants infested)			
	Garcinia gummi-gutta	*Garcinia indica*	*Syzygium cumini*	
	Ceroplates rubens	*Ceroplates rubens*	*Rusostigma eugienie*	*Mealy bugs*
August I FN 2019	6.00	2.50	4.50	3.50
August II FN 2019	10.00	4.50	5.00	4.50
September I FN 2019	14.00	4.50	5.50	5.00
September II FN 2019	16.00	6.50	10.00	6.50
October I FN 2019	18.00	6.50	10.50	6.00
October II FN 2019	19.50	7.00	11.00	8.00
November I FN 2019	21.00	8.00	13.00	8.00
November II FN 2019	23.00	8.00	16.50	8.50
December I FN 2019	25.50	16.00	15.50	10.50
December II FN 2019	24.50	20.00	16.00	10.50
January I FN 2020	20.00	22.00	18.50	10.50
January II FN 2020	12.00	25.50	26.00	12.00
February I FN 2020	10.00	26.50	26.50	13.00

February II FN 2020	8.00	24.50	25.50	13.50
March I FN 2020	5.00	16.50	18.50	10.00
March II FN 2020	4.50	12.50	16.50	8.50
April I FN 2020	4.50	10.50	14.00	9.50
April II FN 2020	4.00	8.00	12.00	8.00
Range	4.00 – 25.50	2.50 – 26.50	4.50 – 26.50	3.50 – 13.50

Table 4: Correlation co-efficient between percentage incidence of insect pests with medium to high level of infestation and weather parameters at College of Forestry nursery, Ponnampet

Host plant	Insect pest		Minimum Temperature	Maximum Temperature	Minimum RH	Maximum RH	Rainfall
Garcinia gummi-gutta	*Ceroplastes rubens*	Pearson Correlation	0.055	-0.034	-0.023	-0.320	-0.284
		Sig. (2-tailed)	0.834	0.897	0.929	0.211	0.269
Garcinia indica	*Ceroplastes rubens*	Pearson Correlation	-0.634**	0.667**	-0.720**	-0.565*	-0.513*
		Sig. (2-tailed)	0.006	0.003	0.001	0.018	0.035
Syzygium cumini	*Rusostigma eugienie* Maskell	Pearson Correlation	-0.737**	0.787**	-0.873**	-0.836**	-0.704**
		Sig. (2-tailed)	0.001	0.000	0.000	0.000	0.002
	Mealy bugs	Pearson Correlation	0.063	0.166	-0.185	-0.307	-0.338
		Sig. (2-tailed)	0.811	0.524	0.477	0.231	0.184

Note: **. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

The incidence of whiteflies on *S. cumini* in the present investigation showed a significant relationship with weather parameters. It was positive with Maximum temperature and negative with Minimum temperature, Minimum RH, Maximum RH and Rainfall (Table 4). These findings are in partial conformity with earlier studies who recorded significant positive correlation between whitefly incidence and Maximum and Minimum temperature in respect of *B. tabaci* and Spiralling whitefly respectively [12, 11].

The Mealy bug infestation on *S. cumini* was at a lower level from first fortnight of March to second fortnight of April, and at medium level from second fortnight of January to second fortnight of February (12.00 to 13.50%)(Table 3). The incidence of this insect recorded non-significant positive correlation with Minimum and Maximum temperature, and non-significant negative correlation with Minimum and Maximum RH, and Rainfall (Table 4). However, in previous studies the significant positive correlation between the occurrence of mango mealybug and Minimum temperature and RH [13]. Again the variation can be attributable to the differences in species of mealybug and the host plant under study in the present and earlier investigations.

The incidence of Chrysomelid beetle and leaf miner on *G. gummi-gutta* ranged from 0.50 to 5.00 and 0.50 to 6.50 per cent, respectively. Similarly, in *G. indica*, the incidence of *P. congregata* varied from 0.00 to 9.00 per cent and that of *Busoniomimus manjunathi* from 8.00 to 11.50 per cent. The intensity of occurrence of aphids and cow bugs on *A. lebbeck* ranged from 2 to 10 and 4 to 8.50 per cent, respectively. On *S. emarginatus* the occurrence of Myllocerous weevil ranged between 0.00 and 6.00 per cent (Table 5).

Table 5: Seasonal incidence of insect pests with low level of incidence at College of Forestry nursery, Ponnampet

Fortnights	Percentage of plants infested						
	Garcinia gummi-gutta		*Garcinia indica*		*Albizzia lebbeck*		*Sapindus emarginatus*
	Podontia congregata	Leaf miner	*Podontia congregata*	*Busoniomimus manjunathi*	Aphids	*Oxyrachis tarandus*	*Myllocerous discolor*
August I FN 2019	3.50	4.50	7.50	8.00	8.00	4.50	3.00
August II FN 2019	2.50	3.50	3.00	9.00	8.50	5.50	6.50
September I FN 2019	3.50	4.00	8.00	8.50	9.00	6.00	5.50
September II FN 2019	4.50	6.00	8.50	9.50	10.00	7.50	4.50
October I FN 2019	4.50	5.50	9.00	10.00	10.00	5.00	0.00
October II FN 2019	5.00	5.50	7.00	10.00	9.50	5.50	0.50
November I FN 2019	4.50	6.50	0.00	10.00	0.50	4.50	2.50
November II FN 2019	2.50	4.00	0.50	10.00	4.50	4.00	0.50
December I FN 2019	3.00	5.00	9.00	10.00	7.50	5.00	5.00
December II FN 2019	2.50	3.00	9.00	11.00	5.00	6.00	6.00
January I FN 2020	2.50	3.00	8.00	10.00	7.00	6.50	3.50
January II FN 2020	0.50	1.50	6.00	10.50	9.50	8.50	5.00
February I FN 2020	1.50	2.50	5.00	11.50	2.00	7.50	4.00
February II FN 2020	1.50	2.50	6.00	10.00	9.50	6.50	4.50
March I FN 2020	1.50	2.00	8.00	8.50	8.00	6.00	5.50
March II FN 2020	1.50	2.00	0.00	10.00	9.00	5.00	4.50
April I FN 2020	0.50	0.50	0.00	8.50	9.50	4.50	5.50
April II FN 2020	0.50	1.50	0.50	8.00	8.50	7.00	4.00
Range	0.50 – 4.50	0.50 – 6.50	0.00 – 9.00	8.00 – 11.50	0.50 – 10.00	4.00 – 8.50	0.50 – 6.50

Table 6: Calendar of insect pests for College of Forestry nursery, Ponnampet

Host plant	Insect pest	Infestation level								
		August	September	October	November	December	January	February	March	April
Garcinia gummi-gutta	*Ceroplastes rubens*	L	M	M	M	H	M	L	L	L
	Podontia congregata	L	L	L	L	L	L	L	L	L
	Leaf miner (Unidentified)	L	L	L	L	L	L	L	L	L
Garcinia indica	*Ceroplastes rubens*	L	L	L	L	M	M	H	M	L
	Podontia congregata	L	L	L	L	L	L	L	L	L
	Busoniomimus manjunathi	L	L	L	L	L	L	L	L	L
Syzygium cumini	*Rusostigma eugienie*	L	L	M	M	M	M	H	M	M
	Mealy bugs	L	L	L	L	L	L	M	L	L
Albizzia lebbeck	Aphids	L	L	L	L	L	L	L	L	L
	Oxyrachis tarandus	L	L	L	L	L	L	L	L	L
Sapindus emarginatus	*Myllocerous discolor*	L	L	L	L	L	L	L	L	L

Note: L – Low (<12%), M - Medium (12-24%) and H – High (>24%)

Pink scales *on Garcinia gummi-gutta*

Leaf miner *on Garcinia indica*

White flies on *Syzygium cumini*

Flea beetle on *Garcinia gummigutta*

5. Conclusion

The close perusal of the findings reveals that Pink scale *Ceroplastes rubens* on *Garcinia gummi-gutta* and *G. indica*, Whiteflies *Rusostigma eugenie* and Mealy bugs on *Syzygium cumini* were the major nursery pests in the present study. The occurrence of Pink scale on *Garcinia* spp. is the first report as new host of this insect. The information on seasonal occurrence of insect pests can be best utilized for planning the management practices.

6. Acknowledgement

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