DOI : [http://doi.org/10.22438/jeb42/4\(SI\)/MRN-1554a](http://doi.org/10.22438/jeb42/4(SI)/MRN-1554a)

Studies on population dynamics of major pests of *Ailanthus excelsa* Roxb

V. Manimaran^{1*}, M.Suganthi², A. Balasubramanian³ and P.Pretheepkumar⁴¹Department of Silviculture and NRM, Forest College and Research Institute, Mettupalayam-641 301, India²Department of Silviculture and NRM, Forest College and Research Institute, Mettupalayam-641 301, India³Department of Silviculture and NRM, Forest College and Research Institute, Mettupalayam-641 301, India⁴National Pulses Research Centre, Vamban-622 303, India*Corresponding Author Email : manimaranfci111@gmail.com

Received: 24.12.2020

Revised: 25.02.2021

Accepted: 03.03.2021

Abstract

Aim: To study the peak period of incidence of major pest of *Ailanthus excelsa*.

Methodology: Seasonal abundance of major insect pests of *A. excelsa* viz., ailanthus defoliator and ailanthus webworm were studied in 5-year-old plantation at Forest College and Research Institute, Mettupalayam from April, 2018 to March, 2019. Weekly observations were made on the abundance of major insect and pest population which were correlated with weekly weather parameters.

Results: Monitoring the population dynamics of insect pests revealed that the major key pests were ailanthus defoliator and webworm. The highest number of ailanthus defoliator (38.00 larvae per tree) and webworm (33.90 larvae per tree) were recorded during 44th standard week in 5-year-old plantation. Correlation analysis revealed that maximum temperature (T_{max}) was negatively correlated with ailanthus defoliator with the r value of -0.299. Regarding webworm, wind velocity and evaporation rate were negatively correlated with the r value of -0.412 and -0.361 and was found to be statistically significant at 1% level.

Interpretation: Seasonal abundance of this information helps us to take decision for the management of *A. excelsa* pests.

Key words: *Ailanthus excelsa*, Defoliator, Population dynamics, webworm

How to cite : Manimaran V., M.Suganthi, A. Balasubramanian and P.Pretheepkumar, Studies on population dynamics of major pests of *Ailanthus excelsa* Roxb. J. Environ. Biol., 42, 1168-1173 (2021).

Introduction

Ailanthus excelsa is a multipurpose, deciduous, fast growing tree species belonging to family Simaroubaceae. It grows well in arid and semi-arid regions, and is suitable for planting in dry areas experiencing annual rainfall of 400 mm. In India, the tree is indigenous to southern and central India and also distributed in Western Peninsula, Rajasthan, Bihar, Orissa, Bundelkhand in Madhya Pradesh, Broach and Panchamal districts of Gujarat, in dry deciduous forests of Maharashtra and scarce in Deccan and Karnataka. It avoids moist areas having high rainfall. It grows in broad range of soil types including sandy soils, adapts to drought stress and can tolerate dry season of 4 to 6 months (Rajasugunasekar, 2014). The demand for *A. excelsa* is increasing due to its multipurpose uses viz., leaves as fodder and stem in the production of match wood, box plank, packing cases, sword sheath, paper, toys, plywood veneers (Sharma et al., 2016), pencil (Lavhale and Mishra, 2007) and fuel wood (Jat et al., 2011). Among the various pests, *Eligma narcissus* and *Atteva fabriciella* are the major pests of *Ailanthus excelsa*. *Eligma narcissus* causes complete defoliation of seedlings in the nursery and up to 95% defoliation in the young plantations up to 5-years-old, resulting in loss of growth increment (Varma, 1996). Defoliation by *Atteva fabriciella* leads to reduction in growth increment due to defoliation of tender leaves, forking of tree due to terminal bud damage and loss of seed production due to damage of inflorescence and fruits (Varma, 1996; Nair, 2007).

Wolda, (1988); Pinheiro et al. (2002) reported that the common phenomenon for the abundance of tropical insect is seasonal variation. Change in insect abundance occurs over time for various reasons such as micro and macro climate change and variation in the availability of food resources. Insect can operate faster and more efficiently at higher temperature and can also feed, develop, reproduce and disperse once the climate is warm,

although they live for a short period (Drake, 1994). Information on weather parameters of standard weeks is important compared to the annual mean to analyze the population dynamics of pests and natural enemies in relation to changing environmental conditions. Understanding this impact of native weather variables on insect population dynamic is vital for managing pests of tropical crops (Lomeli-Flores et al., 2010).

Therefore, this study was undertaken to determine the effect of climatic parameters on the seasonal abundance of insect pests of *A. excelsa*.

Materials and Methods

Seasonal abundance of major insect pests of *A. excelsa* viz., *Ailanthus defoliator* and *Ailanthus webworm* were studied in 5-year-old plantation at Forest College and Research Institute, Mettupalayam from April, 2018 to March, 2019. Weekly observation were made on the abundance of major insect pests on 10 randomly selected trees on three leaves in the lower whorls for *ailanthus defoliator* and three leaves on the crown for *ailanthus webworm*. Weekly counts of insect pest population was correlated with weekly weather parameters viz., maximum temperature (T_{max}), minimum temperature (T_{min}), relative humidity (RH), rainfall, sunshine, wind speed and evaporation rate obtained from Agro-meteorological Observatory at Forest College and Research Institute, Mettupalayam.

Correlation and multiple linear regression analyses were conducted to assess the relationship between seasonal abundance of insect pests in the field and weather parameters viz., maximum temperature (T_{max}), minimum temperature (T_{min}), relative humidity (RH), rainfall, sunshine, wind speed and evaporation rate were carried out using SPSS statistics ver.17.0. (Gomez and Gomez, 1984).

Fig.1.: Seasonal abundance of defoliators infesting 5-year-old plantation of *Ailanthus excelsa* during 2018-2019

Table 1: Monitoring insect pests in 5-year-old plantation of *A. excelsa* during 2018-19*

Date / Months	Standard week	<i>Ailanthus</i> defoliator (No. per tree)	<i>Ailanthus</i> webworm (No. per tree)	Defoliation (%)
2018				
01 to 07 April	14	0.00	0.00	0.00
08 to 14 April	15	0.00	0.00	0.00
15 to 21 April	16	0.00	0.00	0.00
22 to 28 April	17	0.00	0.00	0.00
30 to 06 May	18	0.00	8.50	1.00
07 to 13 May	19	0.00	11.30	5.00
14 to 20 May	20	0.00	19.20	8.00
21 to 27 May	21	0.00	14.10	12.00
28 to 03 June	22	0.00	12.90	15.00
04 to 10 June	23	0.00	9.00	10.00
11 to 17 June	24	0.00	8.10	8.00
18 to 24 June	25	0.00	6.70	5.00
25 to 01 July	26	0.00	2.40	2.00
02 to 08 July	27	0.00	1.80	0.00
09 to 15 July	28	0.00	0.00	0.00
16 to 22 July	29	0.00	0.00	0.00
23 to 29 July	30	0.00	0.00	0.00
30 to 05 August	31	0.00	0.00	0.00
06 to 12 August	32	0.00	0.00	0.00
13 to 19 August	33	0.00	0.00	0.00
20 to 26 August	34	0.00	0.00	0.00
27 to 02 September	35	0.00	0.00	0.00
03 to 09 September	36	0.00	0.00	0.00
10 to 16 September	37	0.00	0.00	0.00
17 to 23 September	38	0.00	0.00	0.00
24 to 30 September	39	0.00	0.00	0.00
01 to 07 October	40	8.40	5.20	2.00
08 to 14 October	41	18.60	10.30	25.00
15 to 21 October	42	25.60	15.40	35.00
22 to 28 October	43	31.20	23.50	55.00
29 to 04 November	44	38.00	33.90	75.00
05 to 11 November	45	28.00	24.30	80.00
12 to 18 November	46	23.50	21.00	82.00
19 to 25 November	47	19.10	17.80	85.00
26 to 02 December	48	16.00	13.40	88.00
03 to 09 December	49	11.30	9.00	70.00
10 to 16 December	50	7.70	7.50	55.00
17 to 23 December	51	3.50	5.10	30.00
24 to 31 December	52	1.20	1.70	10.00
2019				
01 to 07 January	01	0.00	0.90	3.00
08 to 14 January	02	0.00	0.00	0.00
15 to 21 January	03	0.00	0.00	0.00
22 to 28 January	04	0.00	0.00	0.00
29 to 04 February	05	0.00	0.00	0.00
05 to 11 February	06	0.00	0.00	0.00
12 to 18 February	07	0.00	0.00	0.00
19 to 25 February	08	0.00	0.00	0.00
26 to 04 March	09	0.00	0.00	0.00
05 to 11 March	10	0.00	0.00	0.00
12 to 18 March	11	0.00	0.00	0.00
19 to 25 March	12	0.00	0.00	0.00
26 to 01 April	13	0.00	0.00	0.00
Mean	-	4.46	5.44	14.63

* - Data presented without statistical analysis

Results and Discussion

Monitoring of seasonal abundance of insect pests in five years old plantation by direct counting revealed that the highest number of *ailanthus* defoliator was recorded during 44th standard week of 2018 (38.00 larvae per tree) and the minimum number of larvae was recorded during 52nd standard week (1.20). *Ailanthus* defoliator was not noticed till 39th standard week of 2018 in 5-year-old plantation. The incidence started during 40th standard week (8.40 larvae per tree), increased gradually, attained peak during 44th standard week and then declined thereafter. The larval population disappeared from first to 13th standard week of 2019 (Figure 1) and coincide with the findings of findings of Varma (1986) who has reported the peak incidence of both *E. narcissus* and *A. fabriciella* during September to January in 2-year-old plantation of *A. triphysa* in Kerala.

Regarding *Ailanthus* webworm, the highest number of webworm was recorded during 44th standard week (33.90 larvae per tree) and the minimum number larvae was recorded during 1st standard week of 2019 (0.90 larvae per tree). During the observation period of one year, the population of webworm was noticed twice. The first incidence started during 18th standard week (8.5 per tree), increased gradually, attained first peak during

20th standard week (19.20), declined gradually and disappeared from 28th to 39th standard week. Second incidence of webworm started during 40th standard week and extended till first standard week of 2019, with the second peak population (33.90 larvae per tree) during 44th standard week (Table 1). The present study are in conformity with the earlier study, where, *A. triphysa* defoliators was found to be abundant from November to February, coinciding with the general flushing period of tree and smaller population was present throughout the year, thriving on small quantities of new leaves (Varma, 1991) and the peak population of *A. fabriciella* during the onset of monsoon in June-July, with the lowest population in summer months (Mathur *et al.*, 1970).

The results of correlation analysis between weather parameters and abundance of *ailanthus* defoliator revealed that the maximum temperature (T_{max}) was negatively correlated with the population of *Ailanthus* defoliator with the r value of -0.299 and was found to be statistically significant at 5% level. The minimum temperature, relative humidity and sunshine were also negatively correlated with r value of -0.259, -0.143 and -0.364, respectively. Rainfall was positively correlated with r value of 0.206, while, wind velocity and evaporation rate were negatively correlated with r value of -0.495 and -0.499, respectively and were found to be statistically significant at 1% level (Table 2). The

Table 2. Influence of weather parameters on seasonal abundance of *Ailanthus* defoliator and *A. webworm* in 5-year-old plantation during 2018-19

Variables	Correlation coefficient	
	<i>Ailanthus</i> defoliator	<i>Ailanthus</i> webworm
Maximum temperature (T_{max}) (°C)	-0.299**	-0.133
Minimum temperature (T_{min}) (°C)	-0.259	-0.134
Relative humidity (%)	-0.143	-0.222
Rainfall (mm)	0.206	0.163
Sunshine (h/day)	-0.364	-0.091
Wind velocity (km/h)	-0.495*	-0.412*
Evaporation rate (mm)	-0.499*	-0.361*

**Correlation coefficient is significant at 5% level

*Correlation coefficient is significant at 1% level

Table 3. Multiple linear regression analysis for the prediction of seasonal abundance of *Ailanthus* defoliator and *A. webworm* in 5-year-old plantation during 2018-19

Variables	Regression coefficient	
	<i>Ailanthus</i> defoliator (Y_1)	<i>Ailanthus</i> webworm (Y_2)
Intercept (a)	20.526	30.103
Maximum temperature (T_{max}) (°C) (X_1)	1.344*	0.555
Minimum temperature (T_{min}) (°C) (X_2)	0.436	0.908**
Relative humidity (RH) (%) (X_3)	-0.394	-0.429*
Rainfall (mm) (X_4)	-0.013	-0.043
Sunshine (h/day) (X_5)	0.035	4.077*
Wind velocity (km/h) (X_6)	-4.178	-3.960**
Evaporation rate (mm) (X_7)	-7.074**	-10.943*
R^2	0.374	0.463

Regression equations

1) $Y_1 = 20.085 + 1.334X_1 + 0.436X_2 - 0.394X_3 - 0.013X_4 + 0.035X_5 - 4.178X_6 - 7.074X_7$; 2) $Y_2 = 30.103 + 0.555X_1 + 0.908X_2 - 0.429X_3 - 0.043X_4 + 4.077X_5 - 3.960X_6 - 10.943X_7$; **Regression coefficient is significant at 5% level

*Regression coefficient is significant at 1% level

present findings are in conformity with the findings of Kumar et al. (2007) who have reported that tobacco caterpillar, *Spodoptera litura* had non-significant correlation with maximum temperature, minimum temperature, relative humidity and rainfall.

In case of *Ailanthus* webworm incidence, rainfall was positively correlated with webworm population with the r value of 0.163. Whereas, wind velocity and evaporation rate were negatively correlated with the r value of -0.412 and -0.361 and were found to be statistically significant at 1% level. The maximum temperature (T_{max}), minimum temperature (T_{min}), relative humidity and sunshine were negatively correlated with the population of webworm with the r value of -0.133, -0.134, -0.222 and -0.091 (Table 2). The present study is in conformity with the findings of Varma (1986) who reported that occurrence of defoliators was low during rainy season, but there was no definite correlation between pest incidence and rainfall because of population of *A. fabriciella* was observed throughout the year (Varma, 1991) and the population of leaf webber were negatively correlated with minimum and maximum temperature and positively correlated with relative humidity and rainfall in *Vigna mungo* (Umesh et al., 2010).

Multiple linear regression analysis between weather parameters and abundance of *Ailanthus* defoliator in 5-year-old plantation revealed that evaporation rate had significant contribution towards *Ailanthus* defoliator population with the R^2 value of 0.374 at 5% level. When the rate of evaporation increased by 1 mm, the mean number of larval population decreased by 7.074 per tree. The maximum temperature (T_{max}) also had significant contribution towards the defoliator population at 1% level. When the maximum temperature increased by 1°C, defoliator population increased by 1.344 larvae per tree (Table 3).

The minimum temperature and wind velocity had significant contribution towards the abundance of *Ailanthus* webworm at 5% level with R^2 value of 0.463. When minimum temperature increased by 1°C, the webworm population increased by 0.908 larvae per tree, whereas, increase in wind velocity by 1 km h⁻¹ had decreased the webworm population by 3.960 larvae per tree. Relative humidity, sunshine and evaporation rate also contributed significantly towards the webworm population at 1% level. When the relative humidity increased by 1%, larval population decreased by 0.429 per tree whereas increase in sunshine by 1h/day had significantly increased the population of webworm by 4.077 per tree. When the evaporation rate increased by 1 mm, the webworm population decreased by 10.943 larvae per tree (Table 3). The results of present study on defoliators are in conformity with the finding of William and Andrew (1995) who reported that increase in temperature by 2°C had reduced the defoliation by spruce budworm and increased defoliation by gypsy moth. William and Andrew (1995) has also stated that increase in temperature by 2°C with an increase of 0.5 mm precipitation per day had increased the defoliation by both budworm and gypsy moth in spruce. Guedes et al. (2000) reported that 6 to 7 years old plantations of *Eucalyptus grandis* under the temperature of 18°C registered maximum incidence of *Stenalcidia grosica*.

Considering the significance of *Ailanthus* as a multipurpose agroforestry tree species, this study on seasonal abundance of pests of *Ailanthus excelsa* will be helpful to determine the peak period of pest incidence in *Ailanthus* and then correlation between the defoliator population and weather parameters will help to predict the pest outbreak, forewarn the farmers and to determine the management strategies well in advance.

Add-on Information

Authors' contribution: V. Manimaran: Writing full article and statistical analysis; M. Suganthi: Technical guidance for table preparation; A. Balasubramanian: Correction of the manuscript; P. Pretheep Kumar: Reference part.

Research content: The research content is original and has not been published elsewhere.

Ethical approval: Not Applicable

Conflict of interest: The authors declare that there is no conflict of interest.

Data from other sources: Not Applicable

Consent to publish: All authors agree to publish the paper in *Journal of Environmental Biology*.

References

- Drake, V.A.: The influence of weather and climate on agriculturally important insects: An Australia perspective. *Austr. J. Agricul. Res.*, **45**, 487-509 (1994).
- Gomez, K.A. and A.A. Gomez: Statistical Procedures for Agricultural Research. John Wiley & Sons (1984)
- Guedes, R.N.C., T.V. Zanuncio, J.C. Zanuncio and A.G.B. Medeiros: Species richness and fluctuation of defoliator Lepidoptera populations in Brazilian plantations of *Eucalyptus grandis* as affected by plant age and weather factors. *Forest Ecol. Manag.*, **137**, 179-184 (2000).
- Jat, H.S., R.K. Singh, and J.S. Mann: Ardu (*Ailanthus* sp) in arid ecosystem: A compatible species for combating with drought and securing livelihood security of resource poor people. *Indian J. Trad. Know.*, **10**, 102-113 (2011).
- Kumar, R., S. Ali and U. Chandra: Seasonal incidence of insect-pests on *Vigna mungo* and its correlation with abiotic factors. *Annals Plant Protec. Sci.*, **15**, 66-369 (2007).
- Lavhale, M.S., and S.H. Mishra: Nutritional and therapeutic potential of *Ailanthus excelsa*-A review. *Pharmacognosy Reviews*, **1**, 106-116 (2007).
- Lomeli-Flores, J. R., J. F. Barrera and J. S. Bernal: Impacts of weather, shade cover and elevation on coffee leafminer Leucoptera coffeella (Lepidoptera: Lyonetiidae) population dynamics and natural enemies. *Crop Protection*, **29**, 1039-1048 (2010).
- Mathur, R.N., P.N. Chatterjee and S. Sen: Biology, ecology and control of *Ailanthus* defoliator *Atteva fabriciella* Swed. (Lepidoptera: Yponomeutidae) in Madhya Pradesh. *Indian Forester*, **96** 538-552 (1970).
- Nair KS Sadasivan: Tropical Forest Insect Pests: Ecology, Impact, and Management. Cambridge University Press (2007).
- Pinheiro, M.H.O., R. Monteiro and O. Cesar: Levantamento fitossociológico da floresta estacional semidecidual do Jardim

- Botânico Municipal de Bauru, São Paulo. *Naturalia*, **27**, 145-164 (2002).
- Rajagunasekar D.: Cultivation Techniques for *Ailanthus excelsa*, Transfer of Tree Cultivation Technologies: Institute of Forest Genetics and Tree breeding (IFGTB), pp. 19-22 (2014).
- Sharma, M., N. Sharma., K.K. Srivastava, and A. Parmar: Population dynamics of major insect pests on *Ailanthus excelsa* Roxb. and their management in arid and semi-arid areas of Rajasthan and Gujarat. *Indian Forester*, **142**, 900-912 (2016).
- Umesh, C., S. Kumud., H.M. Singh and K. Rakesh: Seasonal incidence of defoliators in urd bean (*Vigna mungo* L. Hepper) and their correlation with meteorological parameters. *Int. J. Plant Protec.*, **3**, 197-199 (2010).
- Varma R.V.: Impact of *Atteva fabricella* (Lepidoptera: Yponomeutidae) on growth of *Ailanthus triphysa*. *Indian Forester*, **122**, 311-316 (1996).
- Varma, R.V.: Spatial and temporal distribution of *Ailanthus* pests, *Eligma narcissus* and *Atteva fabricella*. Kerala Forest Research Institute, KFRI Research Report, **78**, 1-39 (1991).
- Varma, R.V.: Seasonal incidence and possible control of important insect pests in plantations of *Ailanthus triphysa*. Kerala Forest Research Institute, Peechi, Kerala, KFRI Research Report, **39**, 1-42 (1986).
- William, W.D., and M.L. Andrew: Forest defoliators and climatic change: Potential changes in spatial distribution of outbreaks of Western spruce budworm (Lepidoptera: Tortricidae) and Gypsy Moth (Lepidoptera: Lymantriidae). *Environ. Entomol.*, **24**, 1-9 (1995).
- Wolda, H.: Insect seasonality: Why? *Annual Rev. Ecol. Syst.*, **19**, 1-18 (1988).