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Spatial and Temporal Pattern of Budworm (*Hendicasis duplifascialis* H.) Damage on Jasmine (*Jasminum sambac* L.)

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Abstract

Jasmine is an important remunerative flower crop for peasant farmers in Asian countries. Several insect pests attack the popular jasmine genotype, Jasminum sambac L. and reduces its yield. Among the insects budworm, Hendicasis duplifascialis H. (Lepidoptera; Crambidae) is a key pest causing severe damage across the regions. The perennial nature of the jasmine crop succumb damage by the budworm throughout the year. The knowledge on occurrence of budworm and their frequency of potential damage to the flowers is essential to formulate the season-based pest management strategies. The present study was carried out to understand the spatial and temporal pattern of damage by budworms during the different growing season from December 2019 to March 2022. The level of damage at two important jasmine growing regions viz., Trichy and Erode districts of Tamil Nadu, India was estimated. The results indicated that the maximum occurrence of budworm (13.27-19.61%) was recorded during the August- October months. Spatial distribution revealed comparatively more damage at Erode region jasmine fields. Correlation studies revealed the weather factors viz., minimum temperature, evaporation, and rainfall had a significant positive influence on budworm damage. Regression coefficient analysis indicates that budworm incidence was influenced as 64.7 and 59.6 percent by weather parameters at Trichy and Erode regions respectively. The regression equation specified that every unit increase in evening relative humidity, decreases the damage by 1.24 percent at the Trichy region. Significantly one unit increase in sunshine hours increased the damage by 1.17 percent at Erode. From the study, temporal pattern emphasis more damage on jasmine flowers during winter months. Management strategies can be focused to target the pest during the period to avoid loss and obtain profitable yield.

Keywords: *Jasmine, budworm, flower damage, seasonal incidence, weather factors, correlation, regression analysis*

Introduction

Jasmine is an important flower crop in India and Asian countries and fetches good remuneration for small and marginal farmers. The state Tamil Nadu in India ranks highest production of jasmine flowers with the tune of 1.806 lakh tonnes followed by other states like Karnataka (0.238 lakh tonnes) during 2021-22 [1]. Apart from India, it is distributed in Sri Lanka, Pakistan, Nepal, Malaysia, China, Indonesia, France, Spain, Hawaii and tropical Australia [2]. Being perennial crops jasmine flowers are produced throughout the year depending upon the agronomic operations practiced at different regions. Around 300 species of jasmine have been recorded in the genus *Jasminum*. They are widely spread around various temperate parts of the world, among which 40 species belong to India [3-4]. The crop is venerated for its fragrant flowers. The three major commercially cultivated species of jasmine in India are *Jasminum sambac* Linn, *J. auriculatum* Vahl, *J.grandiflorum* Linn [5]. Various parts of the *J. sambac* plants such as leaves, stem, flower, bark and roots are source of high value chemicals. In India, women prefer to use jasmine not only for its traditional importance but also for its value. The oil extracted from jasmine

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is used in the perfumery and cosmetic industries. Jasmine extractions are also has good medicinal properties [6- 9].

Constraints in jasmine cultivation include abiotic factors like seasonal variation, weather factors and biotic stresses such as insect pests and diseases. Insect pests are a major threat in jasmine cultivation and different type of insects attack during the cropping season. Budworm (*Hendicasis duplifascialis* Hampson), leaf webworm (*Nausinoe geometralis* Guenee), blossom midge (*Contarinia maculipennis* Felt), thrips (*Frankliniella scultzei* Trybom) and red spider mite (*Tetranychus urticae* Koch), eriophyid mite (*Aceria jasmine* Chan.) are some of the common pests that attack the crop and causes severe yield reduction. Among various insect pests, jasmine budworm, *Hendicasis duplifascialis* Hampson (Crambidae: Lepidoptera) is an important pest that attacks the flowers and causes yield loss as well as quality of flowers. Jasmine budworm was recorded from India, West Africa and Ceylon [10]. Later in the year the pest was reported in South India [11]. Up to 30 - 70 percent loss in total yield and 40 - 50 percent damage to the flowers was noticed in the Madurai region of Tamil Nadu, India [12]. The caterpillars during the initial stage enter and feed the inner floral content and petals. One larva can damage up to 2-3 buds and leave bore holes on the flowers. In severe case of infestation, webbing also noticed with the adjacent buds.

Influence of weather factors in different crop phenology invites and favors the multiplication and development of these pests [13-14]. Studies on variations in the level of infestation at different periods and locations are essential to predict their severity and formulate season- based management practices. Very few attempts were made earlier on insect pests of jasmine and their seasonal variation. With the background, present study was focused to analyze the spatial and temporal pattern and influence of weather parameters on the incidence of budworm in two major jasmine-growing districts of Tamil Nadu, India.

Materials and Methods

Field experiments were carried out in three major jasmine-growing regions at the Tiruchirappalli and Erode districts of Tamil Nadu from December 2019 to March 2022. The locations of Trichy district, India are two farmers' fields and Horticulture College farm. The geographical locations are Poothavur (10.785°N; 78.567°E), Navalurkuttappattu (10.767°N; 78.577°E) and College farm (10.756°N; 78.615°E) in Trichy. In Erode district three farmers' fields at Velliyampalayam (11.486°N; 77.151°E), Ikkarainegamam (11.507°N; 77.222°E), Thandampalayam (11.499°N; 77.197°E) were selected for conducting the experiments. Seasonal incidence of budworm *H. duplifascialis* was recorded in jasmine cultivar *J. sambac* by following standard protocol.

Seasonal incidence of budworm in jasmine

Ten jasmine plants in each field were randomly selected and tagged. From the tagged plants fortnight observations were taken from August 2019 to September 2020. The jasmine field plot was maintained without any insecticide application. Standard methodologies were followed to record the incidence of budworm [15-16]. The extent of damage by budworm was assessed by recording total number of buds and the number of bored buds in 5 randomly selected branches. The extent of damage was expressed in percent bored buds. The damage of the budworm was recorded by round boreholes in the bud where the caterpillar feeds the inner content. Two or more buds are usually webbed together and are seen with excreta. Under severe infestation only the flower stalks can be seen leaving the worm to feed on the entire flower content.

$$\text{Per cent bored buds} = \frac{\text{Number of buds with bore holes}}{\text{Total number of buds}} \times 100$$

Collection with weather parameters

The primary weather factors such as maximum, and minimum temperature (°C), morning and evening relative humidity (%), wind velocity (km/hour), sunshine hours (hrs), evaporation (mm), and rainfall (mm) were obtained to study the interaction between budworm damage and weather parameters.

Statistical analysis

Mean data obtained from seasonal incidence of insect pests were used to correlate with monthly weather parameters. Regression analysis was also performed using SPSS software (Version 26). A regression equation was worked out for mean budworm damage data of two districts to assess the influence of weather

parameters.

Results and discussion

Budworm incidence in major jasmine cultivation areas

The incidence of budworm on jasmine in different locations of Trichy and Erode districts were shown significant variation among the location as well as different periods. The data were recorded from Dec'2019 to March 2022 in the farmers field and mean damage was worked out. During 2019-20, the maximum incidence of budworm (28.08%) was noticed in Poothavur village, Trichy in September 2020. During the same period 7.34 per cent damage was recorded at college farm but it was maximum level in that location which indicated that there was variation in damage among different location but seasonally similar trend was observed. In Navalur kuttapattu village the damage level was ranged from 2.30 to 18.60 per cent during 2019-2020 (Table 1). The minimum damage at Navalur kuttapattu and Poothavur was noticed during January'20 (2.30%) and February'20 (2.10%) respectively. At college farm the minimum damage was recorded during February'20 (1.70%) and June'20 (1.10%). The mean damage at three locations of Trichy district indicated that minimum incidence during Jan-Feb'20 (3.00 & 2.10%) and maximum damage during Sep-Oct'20 (15.60 & 14.70%). Similarly in Erode district also maximum mean damage was noticed during October '20 (19.79%) and August'20 (18.66%). Minimum bud borer damage was recorded during the summer months of May'20 (3.12%) and June'20 months (4.45%). Among three different farmers' fields observed with budworm damage, it was noticed that maximum damage occurred in Thandampalayam village during September'20 (22.64%) and October'20 (21.56%). In another village Ikkarainegamam also the maximum damage was noticed during August (20.46%) and October (19.02%) months. Minimum budworm damage was recorded during May'20 at Thandampalayam (2.44%) and Ikkarainegamam (3.80%) villages. In Velliyampalaym village of Erode district the minimum damage was noticed during December'19 (2.82%) and May'20 (3.16%). Studies on major insect pests on *J. sambac* revealed that it was infested by five major insects [15]. The maximum incidence of budworm was recorded during September second fortnight (48.88%). Peak occurrence of other insect pests like leaf webworm, *Nausinoe geometralis* and blossom midge, *Contarinia maculipennis* was observed during September second fortnight (5.8 webs /plant and 50.34% infested buds respectively).

In the present study, during 21-22, the mean budworm damage was comparatively lower the previous year. Maximum mean budworm damage was noticed in December'21 (10.40%) followed by July'21 (9.10%). Minimum mean budworm damage was recorded during February (2.10%) and March'21 (1.10%) months. Among three locations in the Trichy district more budworm damage was noticed in Navalur kuttapattu village with 14.60% during December'21. Poovathur village jasmine field also had more damage during the same period (12.50%). At the college farm, during August'21 maximum damage of 5.10 percent was noticed which was lower compared to farmers field. In general, the incidence of budworm was more during August – February and minimum during the summer months. However, after summer months the damage slowly showed an increasing trend depending upon the rainfall pattern and other weather parameters. It was reported that the maximum incidence of budworm (31.94% damaged buds) was observed in the February second fortnight [16]. Another report revealed that the maximum budworm recorded (21.50%) in September and the minimum incidence in November [17].

In Erode district the mean bud borer damage was maximum in September (19.61%) and October'21 (15.87%). Minimum damage was noticed during January (5.32%) and February'22 (7.76%) (Table 2). There was slight variation among the damage level in the two districts on the minimum damage level of budworm (Fig.1). In the year 2022 at Erode district, the damage during Jan-Feb month was more compared to Trichy district. Rainfall and other weather factors might have an impact on the incidence of the same. Maximum occurrence of bud borer was noticed during August's first fortnight with damage of 31.87 percent [18]. The maximum incidence of another bud borer, blossom midge was recorded as 34.27 per cent in the Madurai district of Tamil Nadu [19]. Similarly, maximum occurrence of the jasmine midge was noticed in April (46.74%) and the minimum in November's first fortnight (13.34%) [20] which is in contrast to the budworm incidence in the present study. As midges belong to the dipteran group the damage pattern may vary. The factors favorable for budworm development are full blooming flowers, whereas the midges can damage even at the small young bud stage of the crop.

Influence of weather parameters on jasmine budworm

Correlation and regression studies have been carried out with different weather parameters and budworm damage across two districts. There was a significant correlation between few of the weather factors. Minimum temperature, evening RH, sunshine hours, evaporation and rainfall had a significant correlation with budworm damage at Trichy district (Table 3). Minimum temperature, evaporation and rainfall had a positive correlation with budworm damage, whereas evening relative humidity and sun shine had a negative correlation. The data collected during the entire twenty eight month period at Trichy district denoted that the internal feeder budworm was influenced by day time relative humidity as well as night temperature. Evaporation and rainfall is also influencing the budworm damage. The pest population buildup was more after the summer and during the winter season the pest incidence is slowly declined and reduced in the ensuing summer. Fluctuating incidence of major jasmine pests, *H. duplifascialis, N. geometralis, C. maculipennis, F. scultzei* and *T. urticae* were noticed in response to weather parameters [21]. Linear regression analysis yielded significant regression equations which can be used to predict the incidence of major pests, concerning temperature, relative humidity, rainfall and other weather factors.

Correlation studies at Erode district revealed that minimum temperature, evaporation and rainfall had a significant positive correlation with the budworm damage in the location. Rainfall and evaporation had a positive influence in both locations which narrated the budworm damage was prevalent during the monsoon period. Though sunshine had negative correlation with damage it was not significant at Erode district whereas at Trichy district it had significant impact. Another defoliator pest on jasmine, leaf web worm incidence were positively correlated with maximum temperature (r = + 0.395) [22] in Madurai and Coimbatore districts of Tamil Nadu, India. The variation in pest incidence might be due to prevailing weather parameters in that particular location. The microclimate in the open foliage and flower may vary. In case of a budworm, minimum temperature had a significant influence at both the location in the present study. A significant positive correlation was observed between mites and average temperature in the jasmine cropping system [23]. Evaporation, sunshine hours, and morning relative humidity had a positive effect, and evening relative humidity, rainfall had negative effect on jasmine budworm damage in another study [13]. The incidence of thrips on jasmine was highly significant and positively correlated with maximum temperature (r = 0.632) [15]. In general, the temperature had a significant positive correlation on thrips (r = 0.645) [24].

The regression studies worked out for Trichy district with weather parameter arrived a linear regression equation as $Y = -14.87 - 1.09X_1 + 0.84 X_2 - 0.34 X_3 - 1.24 X_4 + 1.12 X_5 - 2.47 X_6 + 1.01X_7 + 0.87X_8$. The regression coefficient value was 0.647 which indicates that the budworm incidence was 67.7 percent influenced by the weather parameters (Table 4). The regression equation indicates that an increase in one unit of minimum temperature increased the budworm damage by 0.84 percent. One unit increase in evening RH decrease the damage by 1.24 percent, similarly, one unit increase in rainfall increased the damage by 0.87 per cent in the jasmine fields of Trichy district, India. The trend has deviated slightly for the Erode district jasmine field. The regression equation for the damage and weather parameters at Erode district worked out as $Y = -87.74 - 2.44X_1 + 1.03 X_2 - 2.18 X_3 - 1.62 X_4 + 1.27 X_5 - 1.17 X_6 + 0.64X_7 + 0.10X_8$. The regression coefficient value was 0.596 which indicates that the budworm incidence was 59.6 percent influenced by the weather parameters. The regression equation revealed every unit increase minimum temperature increased the damage by 1.03 percent. One unit increase in morning RH decrease the budworm damage by 2.18 percent, similarly, one unit increase in sunshine hours increased the damage by 1.17 percent in Erode district jasmine field. The earlier studies conducted at Thirunelveli district, Tamil Nadu, India indicated that every unit increase in the rainfall resulted in a decrease of 3.38 percent budworm damage [13].

Conclusion

The present findings conclude that jasmine budworm incidence illustrated a typical pattern in major jasmine cultivating areas. Though budworm incidence was noticed throughout the flowering period, the temporal pattern of jasmine budworm indicated that maximum occurrence during August-October. The incidence was increasing after the summer months and peaked during winter in both localities. The spatial distribution of budworm revealed that among two different geographical locations, more damage observed at Erode district on

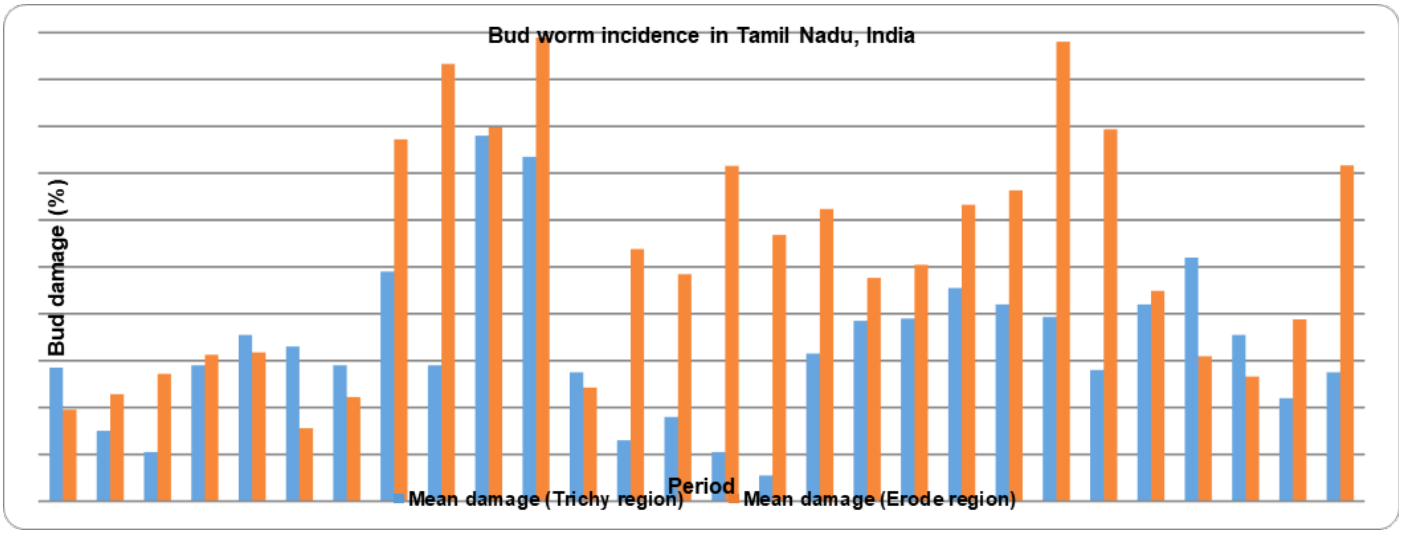

Fig 1. Jasmine budworm damage in Tamil Nadu, India

Table 1. Jasmine budworm damage in Trichy region, India

S.No.	Period/ Locations	Mean budworm damage at different locations*			Mean
		Navalur Kuttapattu	Poothavur	Horticultural College farm	
1.	December '19	3.50±0.12	7.87±0.21	5.70±0.31	5.70
2.	January '20	2.30±0.11	3.25±0.14	3.52±0.21	3.00
3.	February '20	2.43±0.21	2.10±0.19	1.70±0.17	2.10
4.	March '20	5.27±0.10	8.51±0.10	3.57±0.09	5.80
5.	April '20	7.33±0.14	9.15±0.27	4.68±0.12	7.10
6.	May '20	9.45±0.13	8.30±0.11	2.10±0.26	6.60
7.	June '20	8.87±0.25	7.29±0.14	1.10±0.10	5.80
8.	July '20	14.42±0.27	10.20±0.17	4.70±0.21	9.80
9.	August '20	10.42±0.10	11.78±0.07	6.12±0.11	5.80
10.	September '20	11.30±0.24	28.08±0.11	7.34±0.19	15.60
11.	October '20	18.60±0.27	19.03±0.21	6.51±0.12	14.70
12.	November '20	5.81±0.38	6.88±0.15	3.67±0.28	5.50
13.	December '20	3.67±0.17	3.20±0.27	1.01±0.25	2.60
14.	January '21	4.55±0.12	2.63±0.18	0	3.60
15.	February '21	3.10**±0.15**	2.81**±0.23**	0.24**±0.28**	2.10
16.	March '21	1.87**±0.07**	1.03**±0.06**	0.45**±0.05**	1.10
17.	April '21	8.20±0.11	7.20±0.14	3.55±0.12	6.30
18.	May '21	10.15±0.10	9.50±0.36	3.40±0.16	7.70
19.	June '21	11.70±0.17	8.20±0.13	3.35±0.15	7.80
20.	July '21	10.35±0.14	12.75±0.08	4.20±0.06	9.10
21.	August '21	9.30±0.12	10.70±0.11	5.10±0.06	8.40
22.	September '21	9.10±0.25	10.22±0.19	4.27±0.02	7.86
23.	October '21	8.40±0.15	6.30±0.07	2.20±0.07	5.60
24.	November '21	10.85±0.22	9.40±0.04	4.80±0.16	8.40
25.	December '21	14.60±0.07	12.50±0.19	4.10±0.17	10.40
26.	January '22	10.70±0.08	8.35±0.21	2.10**±0.17**	7.10
27.	February '22	6.40±0.08	5.23±0.12	1.43±0.07	4.40
28.	March '22	7.60±0.10	6.47±0.18	2.57±0.27	5.50

Table 2. Jasmine budworm damage in Erode region, India

S.No.	Period/ Locations	Mean budworm damage at different locations*			Mean
		Velliyampalayam	Ikkarainegamam	Thandampalayam	
1.	December '19	2.82±0.06	4.70±0.24	4.22±0.24	3.91
2.	January '20	3.44±**0.14**	5.78±**0.27**	4.50±**0.12**	4.57
3.	February'20	4.54±**0.04**	6.12±**0.25**	5.66±**0.13**	5.44
4.	March '20	5.72±**0.01**	6.94±**0.05**	6.10±**0.25**	6.25
5.	April '20	6.20±**0.04**	7.58±**0.27**	5.28±**0.21**	6.35
6.	May '20	3.16±**0.24**	3.80±**0.16**	2.44±**0.23**	3.12
7.	June '20	4.36±**0.05**	5.28±**0.14**	3.70±**0.15**	4.45
8.	July '20	13.44±**0.17**	17.38±**0.27**	15.50±**0.34**	15.44
9.	August '20	16.38±**0.07**	20.46±**0.22**	19.14±**0.11**	18.66
10.	September 20	10.94±**0.17**	14.28±**0.11**	22.64±**0.20**	15.95
11.	October '20	18.78±**0.24**	19.02±**0.24**	21.56±**0.24**	19.79
12.	November '20	4.54±**0.27**	5.36±**0.22**	4.64±**0.21**	4.85
13.	December '20	8.70±**0.17**	12.90±**0.19**	10.68±**0.20**	10.76
14.	January '21	13.16±**0.34**	9.34±**0.15**	6.58±**0.18**	9.69
15.	February '21	12.68±**0.14**	13.48±**0.16**	16.76±**0.16**	14.31
16.	March '21	11.28±**0.16**	10.98±**0.22**	11.82±**0.12**	11.36
17.	April '21	13.10±**0.28**	11.76±**0.16**	12.56±**0.27**	12.47
18.	May '21	8.88±**0.11**	9.24±**0.17**	10.48±**0.13**	9.53
19.	June '21	8.66±**0.15**	10.40±**0.22**	11.22±**0.11**	10.09
20.	July '21	13.48±**0.22**	12.60±**0.27**	11.88±**0.24**	12.65
21.	August '21	14.08±**0.17**	12.46±**0.11**	13.28±**0.14**	13.27
22.	September '21	21.28±**0.17**	19.68±**0.13**	17.86±**0.16**	19.61
23.	October '21	16.86±**0.24**	15.06±**0.26**	15.68±**0.21**	15.87
24.	November '21	10.48±**0.19**	7.82±**0.11**	8.64±**0.18**	8.98
25.	December '21	6.68±**0.22**	6.06±**0.18**	5.82±**0.15**	6.19
26.	January '22	5.24±**0.27**	4.28±**0.16**	6.44±**0.10**	5.32
27.	February '22	8.46±**0.18**	7.00±**0.14**	7.82±**0.25**	7.76
28.	March '22	14.68±**0.21**	12.82±**0.13**	15.48±**0.21**	14.33

Table 3. Correlation of jasmine budworm incidence with weather parameters

S.No.	Weather factors	Correlation coefficient (r)	
		Trichy	Erode
1.	Maximum temperature (°C)	-0.335	-0.066
2.	Minimum temperature (°C)	0.463*	0.510*
3.	Morning RH (%)	-0.246	-0.183
4.	Evening RH (%)	-0.541*	-0.179
5.	Wind velocity (km/hr)	0.058	0.271
6.	Sun shine (hrs)	-0.474*	-0.325
7.	Evaporation (mm)	0.451*	0.528*
8.	Rainfall (mm)	0.449*	0.481*

* Significant at 5% level

Table 4. Multiple linear regression analysis of mean budworm damage with weather parameters

Variables	Partial regression coefficient	Standard error	't' value	R^2
Trichy region				
X_1 - Maximum Temperature	-1.09	2.18	1.24	0.6470
X_2 - Minimum Temperature	0.84	1.57	0.34	
X_3 - Morning Relative Humidity	-0.34	1.07	-1.47	
X_4 - Evening Relative Humidity	-1.24	0.22	-0.57	
X_5 - Wind Velocity	1.12	0.54	0.27	
X_6 - Sunshine Hours	-2.47	0.87	-0.18	
X_7 – Evaporation	1.01	2.45	0.57	
X_8 – Rainfall	0.87	0.57	0.54	
Regression equation	$Y = -14.87 -1.09X_1 +0.84X_2 -0.34X_3 - 1.24X_4 + 1.12X_5 - 2.47X_6 + 1.01X_7 + 0.87X_8$			
Erode region				
X_1 - Maximum Temperature	-2.44	1.41	0.34	0.5961
X_2 - Minimum Temperature	1.03	1.27	-1.27	
X_3 - Morning Relative Humidity	-2.18	1.64	0.29	
X_4 - Evening Relative Humidity	-1.62	2.14	-0.14	
X_5 - Wind Velocity	1.27	0.27	0.23	
X_6 - Sunshine Hours	-1.17	0.27	-0.87	
X_7 – Evaporation	0.64	2.19	-0.41	
X_8 – Rainfall	0.10	1.24	0.29	
Regression equation	$Y = -87.74 - 2.44X_1 + 1.03X_2 - 2.18X_3 - 1.62X_4 + 1.27X_5 - 1.17X_6 +$			$0.64X_7 + 0.10X_8$

the same cultivar of jasmine, *J.sambac*. The influence of weather factor on the damage of jasmine budworm was evident. Minimum temperature, evaporation and rainfall had significant impact on budworm damage at both locations. Further studies can be made to develop calendar-based management strategies with biological or chemical methods to target the pest during their peak incidence.

Conflict of interest

The authors declare no conflict of interest in the study.

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