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INCIDENCE OF A SEVERE BUD BORER IN CARNATION (*DIANTHUS CARYOPHYLLOUS* L.) CV. CHABAUD MIX IN THE UPPER BRAHMAPUTRA VALLEY AGRO-CLIMATIC CONDITIONS OF ASSAM

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Abstract– The genus *Helicoverpa* is a polyphagous insect belonging to the order Lepidoptera that creates havoc in range of crops worldwide and is one of the most important and serious insect pests in carnation. During the field experiment of the Chabaud carnation (*Dianthus caryophyllous* L.) in the horticultural research farm of Assam Agricultural University, Jorhat, Assam, (India) during 2023, *Helicoverpa armigera* was found ravaging the carnation crop in the experimental field. The present preliminary study sought to examine the correlation between pest infestation and prevailing weather conditions. The sporadic occurrence (0.73%) of the pest started on 13th January and became widespread in the following months. The peak infestation was observed during March and April, and the maximum incidence (18.62%) was recorded from 1st April to 15th April. There was a positive and strong correlation between the incidence (%) of bud borer and minimum temperature (r= 0.90) and rainfall (r= 0.76). Likewise, the maximum RH had a negative and strong correlation (r= 0.74) with borer incidence (%). Meanwhile, the maximum temperature had a positive and moderate correlation (r= 0.67). Additionally, the minimum RH (r= 0.39) and bright sunshine hours (r= -0.36) had weak correlations with bud borer incidence (%). The present study found that the prevailing environmental conditions, the minimum temperature and average mean rainfall in particular had a significant influence on the incidence of insects on chabaud carnation. Bud borers cause serious havoc and damage to the developing flower bud in all stages, piercing, penetrating and feeding inside the bud, eventually leaving the flower bud hollow, empty, redundant and unproductive.

INTRODUCTION

A voracious feeder, the bud borer (*H. armigera* Hübner), belongs to the order Lepidoptera, is considered the world's most destructive insect pest in agriculture and is distributed across the globe due to its high mobility, facultative diapause, polyphagous nature (Pinto *et al*., 2017), high fecundity rate (Reigada *et al*., 2016) and resistance to insecticides (Shimizu and Fujisaki, 2006). It has the potential to cause significant economic losses in a range of crops. *H. armigera* can travel long distances in search of suitable host plants or to escape unfavourable environmental conditions (Jones *et al*., 2019). It has been estimated that *H. armigera* has 300 host plant species (Sarate *et al*., 2012) that include both cultivated crops and weeds belonging to 45 families (Tay *et al*., 2013). Thus, it is a ubiquitous insect pest in agricultural crops.

The occurrence of bud borers (*H. armigera* Hübner) in India is common and has been reported from different places, including the present research area, Assam Agricultural University, Jorhat (India), but in different crops, viz., Harshita *et al*. (2018a) in tomato and a report of *H. armigera* Hübner causing havoc in rapseed crops in the Dhemaji district of Assam by Borthakur *et al*. (2023).

Carnations, one of the most popular ornamental crops grown worldwide and known for its beauty, long-lasting flowers and range of colours and shapes, are mostly commercially cultivated under protected conditions for quality flowers and to protect them from biotic and abiotic stresses, as they are quite susceptible to these factors. The bud borer

(*Helicoverpa armigera* Hübner) is one of the most important pests that causes serious damage to carnation (Multani and Sohi, 2002). It damages the entire flower bud by feeding on it, rendering its flower bud hollow and unproductive. Nevertheless, reports on its infestation in carnations from India remain scarce. Pal *et al*. (2015) in West Bengal and Raj *et al*. (2019) in Jammu and Kashmir have made some empirical reports on infestation of *H. armigera* Hübner in carnations. We believe that there has not been a report on the infestation of *H. armigera* on carnations from the present study area (Jorhat) or from northeast India to date.

Considering the above facts, the present study was carried out to record, report and identify the infestation of *H. armigera* Hübner in carnations grown in open field conditions to understand their incidence, intensity and correlation with prevailing weather conditions.

MATERIALS AND METHODS

Location of the experimental farm

The present study was carried out at the Horticultural Research Farm of Assam Agricultural University, Jorhat, India, during 2023. The farm is located at 26°43'36.99"N, 94°12'06.84''E and 116 M above sea level.

Data collection and analysis

Inspection and data collection were performed at 15-day intervals immediately from the first appearance of the insect in the crop. A total of 100 random plants (N=100) were selected for inspection/ observation and data collection as representatives of the plant population (N=225) and tagged. Infested and noninfested flower buds were counted, and the incidence % was calculated by using the following formula (Abott, 1925):

$$\text{Flower bud borer infestation} = \frac{\text{IFBPP}}{\text{TNPP}} X100$$

where FBIPP stands for the number of flower buds infested per plant and TNPP stands for the total number of flower buds per plant.

The data collection began with the date of the eventual visible appearance of insects until the harvesting stage of the crop. Meteorological data were collected from the Department of Agro-meteorology, Assam Agricultural University, Jorhat (India) to find the correlation of the prevailing weather conditions and incidence of the pest. Bud borer was confirmed by microscopic examination and by referring to the morphological characteristics of *Helicoverpa armigera* described by Yamasaki *et al*. (2009) and Queiroz-Santos *et al*. (2018). Pearson's and Spearman's correlation coefficients were used for analysis and interpreted by correlation guidance (Table 1) developed by Cieniawska *et al*. (2022). The data collected were subjected to statistical analysis for correlation coefficients using OPSTAT, online statistical analysis software.

Table 1. Interpretation of the correlation coefficient (Cieniawska *et al*., 2022).

Correlation coefficient	Interpretation
0	No linear relationship
0 to 0.40 or -0.40 to 0	Weak, positive or negative linear correlation
<0.40 to 0.70 or -0.70 to -0.40>	Moderate, positive or negative linear correlation
<0.70 to 0.90 or -0.90 to -0.70>	Strong, positive or negative linear correlation
0.90 to 1 or -1 to 0.90>	Very strong, positive or negative linear correlation
+1 or -1	Perfect positive or negative linear correlation

RESULTS

The data pertaining to the incidence of insects (*H. armigera* Hübner) presented in Table 2 show that the crop transplanted on 1st December remained free from any kind of insect pest infestation for at least 44 DAT. The sporadic incidence of *H. armigera* Hübner started on 13th January and became more visible by 28th January (0.73%).

The population and infestation of bud borers/ plants gradually increased thereafter and became widespread with light rainfall in February. The peak stage of infestation was recorded during March and April. The maximum bud borer incidence (%) was recorded between 16th March and 31st March (18.47%) and 1st April and 15th April (18.62%). Small larval instars as well as adult larvae pierced into the bud and fed on a large number of flower buds at different developmental stages, viz., the rice stage, pea stage, chickpea stage, barrel stage, paintbrush stage and full bloom stage. The aggressiveness of the bud borer was such that it left the flower bud hollow and unproductive. It remains inside the pod for some time and then moves to the next bud (Fig. 1 & 2). In the later stage, the infestation of the insect

Table 2. Incidence (%) of bud borer in carnation and prevailing weather conditions

Months	Incidence %	Temp (Maxi.)	Temp (Mini.)	RH (Maxi.)	RH (Mini.)	Av. Rainfall (mm)	Bright sunshine (hours)
December	0.00	25.80	11.40	99.40	58.26	0.00	6.42
1st Jan -12 Jan	0.00	24.60	8.00	99.00	50.41	0.00	7.40
13th Jan - 28th Jan	0.73	23.00	8.00	98.06	58.43	0.00	4.80
29th Jan -12 Feb	8.51	25.00	12.30	99.33	59.66	0.60	3.20
13th Feb - 28th Feb	13.37	25.80	13.40	97.26	57.13	2.10	4.70
1st Mar - 15th Mar	15.35	29.30	14.60	94.26	46.60	0.00	6.00
16th Mar - 31st Mar	18.47	24.60	15.90	97.62	73.50	5.40	2.30
1st April - 15th Apr	18.62	28.30	17.60	94.66	62.06	6.50	5.90
16th Apr - 1st May	18.52	30.50	19.70	93.12	60.06	2.80	5.30
2nd May - 17th May	17.22	30.60	20.20	91.37	61.75	3.70	5.60

Meteorological data source: Department of Agro-meteorology, Assam Agricultural University, Jorhat (India)

Fig. 1. Bud borer feeding and damaging flower buds of carnation cv. Chabaud Mix

Fig. 2. Damaged flower buds and borer resting and feeding on flowers of carnation cv. Chabaud Mix

started declining as the crop started to senesce, and the number of buds decreased after blooming.

The correlation of the incidence (%) of bud borers with the prevailing environmental conditions (temperature, humidity, rainfall and bright sunshine hours) was found to be significantly different among the weather parameters (Table 3). The maximum temperature (r= 0.67) had a moderate and positive correlation with bud borer infestation (%), whereas the minimum temperature (r=0.90) had a strong and positive correlation with borer incidence. The prevailing maximum RH (r= -0.74) had a strong and negative correlation, whereas the minimum RH (r= 0.39) had a positive and weak correlation with bud borer incidence (%).

Table 3. Correlation between weather parameters and incidence (%) of bud borer (*H. armigera* Hübner)

Weather parameter		R Value
Temp (°C)	Maxi.	0.67
	Mini.	0.90
RH (%)	Maxi.	-0.74
	Mini.	0.39
Rainfall	Mm	0.76
Sunshine	Hour	-0.36

The average mean rainfall (r= 0.76) had a strong and positive correlation with borer incidence (%). Meanwhile, bright sunshine hours had a negative (r= -0.36) and weak correlation with the incidence of bud borers.

From Figure 3, it can be seen that despite having strong and positive or negative correlation, the average rainfall (r= 0.76) and the maximum RH (r= -0.74) had no linear correlation with the incidence of bud borers in the Chabaud carnation. Likewise, as it is revealed from the correlation study that the minimum RH (r=0.39) and bright sunshine hours (r= -0.36) had a weak correlation, the scatter plot further shows that the results of incidence recorded and predicted scattered apart, and no linear relationship can be established. Among the weather parameters, only the minimum tempearture (r= 0.90) had nearly linear correlation with borer incidence (%).

DISCUSSION

Chabaud carnation cv. Chabaud Mix is a floriferous flowering plant that flowers profusely for a long period. It is a spray-type carnation that is largely used as loose flowers and occasionally sprayed cut

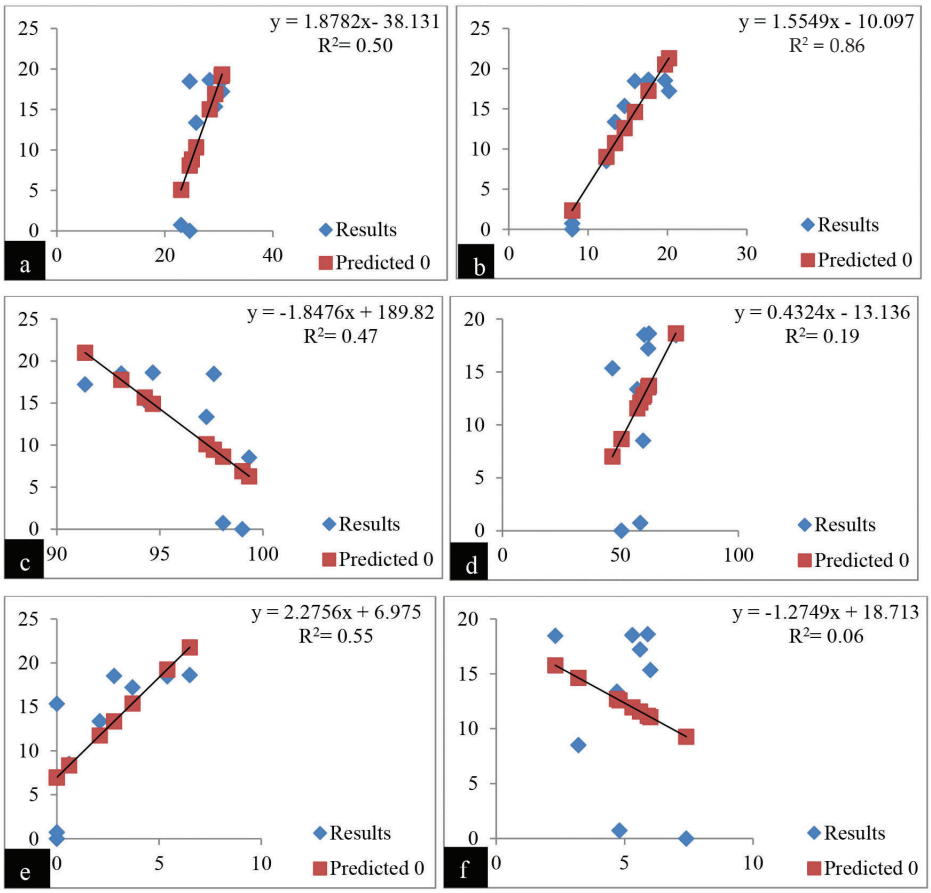

Fig. 3. Regression analysis (Scatter plots) of incidence of bud borer and a) maximum temperature; b) minimum temperature; c) maximum RH; d) minimum RH; e) average rainfall and f) sunshine hours

flowers. It bears a large number of flower buds and flowers, with an average of 37.02 (Maitra and Roychowdhury, 2014). The damage caused by the bud borer is immense and serious in carnations, as it not only renders the flower bud hollow and unproductive at the bud stage but also damages the flower whorl and litters the bloom with its feces. Borers feed mostly on young developing flower buds and late bud stages, and damage to full bloom flowers is limited.

The bud borer first appeared in the month of January but in small numbers and in a sporadic nature. The level of damage during this period was not very visible, and the population of insects was also scattered. However, it drastically increased with the rising temperature and amount of rainfall from 16th March to 31st March and 1st April to 15th April by 18.47 and 18.62%, respectively.

The minimum temperature and average annual rainfall had a strong positive correlation with borer incidence (%). Likewise, the maximum RH had a negative and strong correlation with the borer incidence. Additionally, the maximum temperature had a moderate and positive correlation with borer incidence. In contrast, the minimum RH had a positive but weak correlation. Similarly, sunshine hours had a positive but weak correlation with pest incidence (%).

Furthermore, regression analysis revealed that only the minimum temperature had a nearly linear correlation with bud borer incidence (%). This shows that with an increase in the minimum temperature, there was a gradual increase in the percent infestation of the bud borer in the crop. The rest of the weather was either strongly or moderately correlated, but there was no linear relationship between the incidence of borer infestation and changes in weather parameters, viz., maximum temperature, maximum RH, minimum RH, rainfall and sunshine hours.

This result was consistent with that of Pal *et al*. (2015b), who reported a mean infestation of *H. armigera* of 17.12% in Farida and 18.86% in charment cultivars of standard carnation. A similar result was reported by Harshita *et al*. (2018b) from the same experimental farm (Assam Agricultural University, Jorhat), where the population or number of larvae/plant (6.06) of *H. armigera* increased with increased temperature, humidity, and bright sunshine hours in tomato crops. In contrast, Raj *et al*. (2019) reported a peak incidence (10.06%) of bud borer (*H. armigera*) infestation in July in carnation cv. Red King under protected conditions.

CONCLUSION

The present study found that the carnation cv. Chabaud Mix is very susceptible to bud borers (*H. armigera*). The incidence (%) of bud borer was highly influenced by the prevailing environmental conditions, which favor the insect population under ambient conditions; rainfall and minimum temperature in particular had a significant correlation with the magnitude of infestation. The peak period of infestation was from 16th March onwards when frequent rainfall had taken place and the maximum incidence (%) was observed from 1st April to 15th April. Bud borers in carnation crops have the potential to cause economic losses by feeding, damaging young developing as well as later stages of flower buds, including flowering calyx, very often rendering them unproductive and unsuitable. Therefore, to avoid pest infestation and heavy crop damage, it is highly recommended that Carnations be transplanted either during the last week of September or the first week of October under Assam conditions.

Conflict of interest

The authors declare no conflicts of interest.

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