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Full Research Article

Influence of Abiotic Factors on Pheromone Trap Catches and Field Infestation of *Helicoverpa armigera* on Carnation (*Dianthus caryophyllus*) in Hilly Region of West Bengal, India

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Abstract

An experiment was carried out at Regional Research Station, Uttar Banga Krishi Viswavidyalaya, Kalimpong, during the winter seasons of 2008-09 and 2009-10, to study the impact of weather factors on pheromone trap catches and field infestation of *Helicoverpa armigera* (Hubner) on carnation (*Dianthus caryophyllus* Linnaeus). Various abiotic parameters like maximum and minimum temperature, maximum and minimum relative humidity and rainfall registered low level of non-significant association with the trap catch data during both the seasons. The simple regression equations of pheromone trap catch data with the meteorological parameters indicated that the abiotic factors had non-significant influence on the trap catches of *H. armigera* moths. The maximum temperature and rainfall was responsible for the maximum 26.82 and 8.79% variation in the trap catch data during 2008-09 and 2009-10, respectively.The multiple regression analysis showed that the combined effect of all the meteorological parameters was also statistically non-significant, though 62.88 and 69.13% variation in trap catches was due to weather factors, during 2008-09 and 2009-10, respectively. The correlation coefficients (r) between the field infestation data (number of eggs and larvae plant^{-1}, % bud infestation) and various meteorological parameters revealed that the ecological factors mostly registered non-significant correlation with the field incidence of the pest as well as with the actual infestation of buds and flowers of carnation. Only the minimum temperature was positively and significantly associated with the % bud infestation during both the years.

1. Introduction

Carnation, *Dianthus caryophyllus* Linnaeus, family Caryophyllaceae is native to the Mediterranean region and is an excellent ornamental plant mainly used as cut flowers. It is one of the top ten cut flowers of the world. In India, its cultivation on commercial scale has gained popularity in the recent past. Large scale intensive cultivation of carnation especially under protected condition necessitates high input use including fertilizers and pesticides which can alter the crop-pest equilibrium inviting a number of problems. The attack by insects, mites and other pests increased manifold in recent past.The bud borer, *Helicoverpa armigera* (Hubner) is an important pest of ornamental plants causing serious damage to the buds and flowers (Sood, 1988; Multani and Sohi, 2002). The extent of damage in terms of per cent bud infestation ranges from 10 to even 80% in various cultivars of carnation, *Dianthus caryophyllus* Linn. (Chauhan and Sharma, 2004). Synthetic insecticides are the widely followed means of controlling this pest. But growing concerns over the hazardous effect of pesticide use by the public as well as the producers, risk of residues in the products and banning of some conventional insecticides have prompted growers to adopt alternative pest control methods. Moreover, off late the pest has developed resistance to most conventional insecticides (Kranthi et al., 2002). Therefore, it is important to lay emphasis on an integrated comprehensive approach to combat this pest menace. Moreover, any sustainable and viable pest management programme can not be successful without proper knowledge of the population fluctuation of the pest on the respective host plant. Monitoring of adult moths with pheromone traps is one of the important components

in the integrated pest management (IPM) of *H. armigera*. The study of interactions between the weather parameters and incidence of the pest is of paramount importance for the proper understanding of its infestation pattern.The influence of abiotic environmental factors on the incidence of *H. armigera* has been studied by Upadhyay et al.(1989); Patnaik and Senapati (1996); Kaushal (1997); Gupta and Raj (2002); Metange et al. (2004). Therefore, the present investigation was undertaken with the objectives to study the impact of weather factors on pheromone trap catches and field infestation of *H. armigera*.

2. Materials and Methods

The experiment was carried out in the naturally ventilated low cost polyhouse on a standard type carnation variety 'Sunrise' at Regional Research Station, Uttar Banga Krishi Viswavidyalaya, Kalimpong (27°04′ N; 88°35′ E; 1250 meter above the mean sea-level in the hill zone), Darjeeling, West Bengal during winter seasons of 2008-09 and 2009-10. Rooted cuttings were planted at a spacing of 25×25 cm^2 and raised following normal agronomical practices. Pheromone traps (Polythene sleeve type) baited with 'Helilure' (rubber septa) were installed at 1 meter height from the ground level just above the crop canopy @ 12 traps ha^{-1} in the experimental area. The rubber septum containing the lure was changed after every 15 days. The adult male moths trapped were collected daily and the total number of moths caught during a standard week was counted. The meteorological data were collected from the meteorological unit of Regional Research Station during the period of the study. Simple correlation coefficient(r) was derived between the number of male moth trapped during a standard week and the average maximum temperature, minimum temperature, maximum relative humidity, minimum relative humidity and total rainfall during that week. Similarly the impact of meteorological parameters on the field infestation (number of eggs, larvae and per cent bud borer infestation) of *Helicoverpa armigera* was assessed through correlation studies. To find out the individual as well as combined influence of the abiotic factors on the adult trap catches of *Helicoverpa armigera*, qualitative relationship between the weekly mean trap catches and weather parameters individually and collectively was worked out using simple and multiple regression analysis as per Gomez and Gomez (1984). The qualitative relationship were expressed in the form of mathematical equations i.e. (Y=bX+a). Mean trap catches were considered as dependent variable (Y) and the mean weather factors as independent variable (X). The 'F' test and student't' test (Fisher and Yates, 1938) were applied to test the significance at 5 and 1% levels. The statistical analysis was done in computer using LINEST in excel and OPSTAT statistical package.

3. Results and Discussion

The relationships between adult activity and various abiotic factors (presented through Figure 1 and 2 were worked out through correlation and regression analysis. The perusal of theresults reveals that the abiotic parameters mostly registered low level of non-significant association with the trap catch data (Table 1). The simple regression equations of pheromone trap catch data with the meteorological parameters during 2008-09 and 2009-10 also confirmed the fact that individually the abiotic factors influenced very little on the trap catches of *H. armigera* moths (Table 2 and Table 3). None of the abiotic parameters exerted any significant influence statistically on the adult trap catches as evident from the estimated value of 'T'. During 2008-09, the maximum temperature was responsible for the maximum 26.82% variation in the trap catch data as evident from the Coefficient of determination (R^2) value. When other environmental factors were constant, for every 1 °C increase in maximum temperature there was

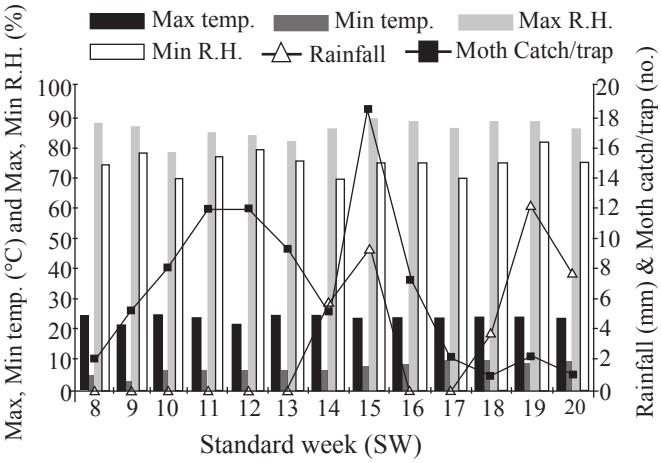

Figure 1: Pheromone trap catches and abiotic factors during 2008-09

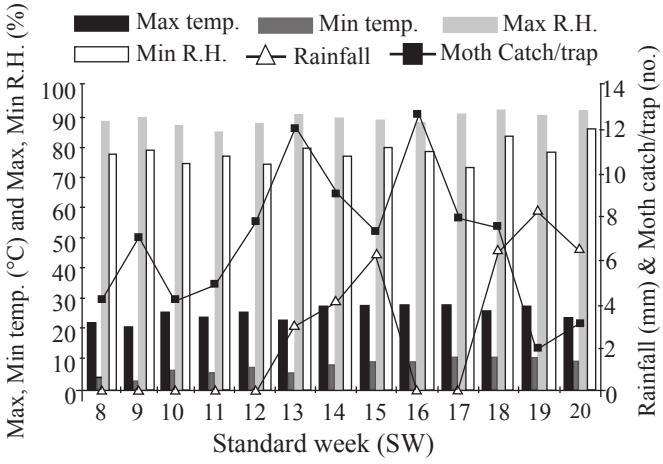

Figure 2: Pheromone trap catches and abiotic factors during 2009-10

Table 1: Correlation coefficient (r) between weekly adult catch in pheromone traps and meteorological parameters

Meteorological parameters	Correlation coefficient (r) during	
	2008-09	2009-10
Maximum temperature (°C)	-0.518 (NS)	0.176 (NS)
Minimum temperature (°C)	-0.384 (NS)	-0.040 (NS)
Maximum R.H. (%)	-0.282 (NS)	0.170 (NS)
Minimum R.H. (%)	-0.203 (NS)	-0.207 (NS)
Rainfall (mm)	-0.045 (NS)	-0.296 (NS)

NS: Non-significant

Table 2: Regression equations of adult trap catch with meteorological parameters during 2008-09

Meteorological parameters	Regression equation Y=bX+a	Coefficient of Determination (R^2)	'T' estimated
Maximum temperature (°C)	Y=−1.957 X+54.039	0.2682	2.008
Minimum temperature (°C)	Y=-0.884 X+12.434	0.1477	1.381
Maximum R.H. (%)	Y=-0.379 X+39.510	0.0796	0.975
Minimum R.H. (%)	Y=-0.311 X+30.180	0.0410	0.686
Rainfall (mm)	Y=-0.058 X+6.708	0.0021	0.151

a decrease of 1.957 number of moth trap catches. During the second year, i.e., 2009-10 the meteorological factors exerted less influence on the adult trap catches of *Helicoverpa armigera* as evident from low R^2 values Table 3. This trend of results draws support from the findings of Kaushal (1997) who also observed mostly non-significant correlation between the trap catch of carnation bud borer and various abiotic parameters at Solan, Himachal Pradesh. Khaliq and Yousaf (1986) working on cotton ecosystem in Pakistan also observed environmental factors to have no effects on captures of *H. armigera*. But, Metange et al. (2004) and Varshney et al. (2005) observed a significant positive correlation between pheromone trap catches and temperature. Studies conducted in Himachal Pradesh by Verma et al. (1994) also revealed that temperature played an important role in regulating adult activity of *H. armigera*.

The multiple regression analysis of the pheromone trap catches data with the abiotic factors for the two consecutive seasons reveals that the combined effect of all the meteorological parameters was also statistically non-significant up to 95 % probability level as evident from the estimated values of 'F' (Table 4 and 5). Together all the weather factors was responsible for 62.88% variation in the adult male moth catch in pheromone trap during 2008-09 and 69.13% during 2009-10. However, in the presence of other factors, the maximum temperature during 2008-09 and the rainfall, maximum and minimum temperature during 2009-10 were found to have significant individual impact on the adult trap catch as evident from the significant regression coefficients as indicated by the t-test statistics value. These observations are in accordance with the findings of Gupta and Raj (2002) who also reported that the combined effect of all the abiotic factors on the pheromone trap catches of *Helicoverpa armigera* was non-significant. But the present findings are in contradiction with the earlier reports of Bijjur and Verma (1996) who found a significant cumulative effect of abiotic factors on the

Table 3: Regression equations of adult trap catch with meteorological parametersduring 2009-10

Meteorological parameters	Regression equation Y=bX+a	Coefficient of Determination (R^2)	'T' estimated
Maximum temperature (°C)	Y=0.254 X+0.625	0.0310	0.593
Minimum temperature (°C)	Y=-0.052 X+7.214	0.0016	0.132
Maximum R.H. (%)	Y=0.332 X−22.362	0.0290	0.573
Minimum R.H. (%)	Y=-0.200 X+22.236	0.0427	0.701
Rainfall (mm)	Y=-0.317 X+7.652	0.0879	1.029

Table 4: Multiple regression equations of adult trap catch with meteorological parameters during 2008-09

Regression equation	Coefficient of Determination (R_2)	'F' estimate
$Y=64.745-1.801\ X_1-0.166\ X_3$	0.2818	1.962
$Y=109.622-2.957\ X_1^*-0.384\ X_3+0.736\ X_5$	0.4599	2.555
$Y=233.756-6.521\ X_1^*+2.356\ X_2-0.143\ X_3-0.983\ X_4+0.876\ X_5$	0.6288	2.371

X_1: Max. temp; X_2: Min. temp.; X_3: Max. R.H.; X_4: Min. R.H.; X_5: Rainfall; *Significant at 5% level

Table 5: Multiple regression equations of adult trap catch with meteorological parameters during 2009-10

Regression equation	Coefficient of Determination (R_2)	'F' estimate
$Y=-19.109+0.191\ X_1+0.241\ X_3$	0.0445	0.233
$Y=-96.015+0.578\ X_1+1.032\ X_3-0.878\ X_5^*$	0.4039	2.033
$Y=-196.438+4.375\ X_1^*-2.893\ X_2^*+0.329\ X_3+1.174\ X_4-1.045\ X_5^*$	0.6913	3.135

X_1: Max. temp; X_2: Min. temp.; X_3: Max. R.H.; X_4: Min. R.H.; X_5: Rainfall; *Significant at 5% level

population of the pest.

The ecological factors mostly registered non-significant correlation with the field incidence of the pest as well as with the actual infestation of buds and flowers of carnation (Table 6 and 7). This trend of results is in conformity with the findings of Dahiya et al. (1997) who observed that various abiotic factors were not consistently correlated with the incidence of *H. armigera*. Dhembare (2001) also reported non-significant correlations between rainfall, minimum temperature and maximum temperature, morning relative humidity, evening relative humidity and the larval populations of *H. armigera* on safflower. In the present study only the minimum temperature showed a significant and positive correlation with the % bud infestation during both the years. During 2009-10 the maximum temperature registered significant and positive association with the number of eggs, larvae plant^{-1} as well as % bud infestation. Earlier, Metange et al. (2004) observed that the egg laying of *H. armigera* was positively and significantly correlated with maximum and minimum temperatures. Similarly, the larval population of *H. armigera*

Table 6: Correlation of field infestation of *H. armigera* with meteorological parameters during 2008-09

Weather parameters	Field incidence		
	No. of eggs plant^{-1}	No. of larva plant^{-1}	Bud infestation (%)
Max. Temp. (°C)	-0.085	0.243	0.419
Min. Temp. (°C)	0.003	0.329	0.586*
Max. R.H. (%)	0.029	0.286	0.375
Min. R.H. (%)	-0.310	-0.202	0.036
Rainfall (mm)	0.060	0.119	0.244

*Significant at 5% level

Table 7: Correlation of field infestation of *H. armigera* with meteorological parameters during 2009-10

Weather parameters	Field incidence		
	No. of eggs plant^{-1}	No. of larva plant^{-1}	Bud infestation (%)
Max. Temp. (ºC)	0.666*	0.695**	0.868**
Min. Temp. (ºC)	0.408	0.495	0.774**
Max. R.H. (%)	0.184	0.072	0.267
Min. R.H. (%)	-0.447	-0.378	-0.290
Rainfall (mm)	0.113	0.138	0.290

*Significant at 5% level; **Significant at 1% level

showed a positive correlation with maximum and minimum temperature and relative humidity (Upadhyay et al., 1989). On the other hand, Patnaik and Senapati (1996) found significant negative correlation between temperature (mean minimum and maximum) and larval incidence.

4. Conclusion

The abiotic factors were found to have little influence on the pheromone trap catches and field infestation of *H. armigera* during the experimental period in this region.

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