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Research Article

Seasonal population fluctuations of cotton bollworm, *Helicoverpa armigera* (Hübner) in relation to biotic and abiotic environmental factors at Raichur, Karnataka, India

M. PRATHEEPA[1*], K. MEENA[2], K. R. SUBRAMANIAM[3], R. VENUGOPALAN[4] and H. BHEEMANNA[5]

[1]*National Bureau of Agriculturally Important Insects, Post Bag No. 2491, H. A. Farm Post, Hebbal, Bellary Road Bangalore 560024, Karnataka, India.*
[2]*Shrimathi Indira Gandhi College, Tiruchirappalli 620002, Tamil Nadu, India.*
[3]*Department of M.C.A., Shrimathi Indira Gandhi College, Tiruchirappalli 620002, Tamil Nadu, India.*
[4]*Indian Institute of Horticultural Research, Hessaraghatta Lake Post, Bangalore 560089, Karnataka, India.*
[5]*Department of Entomology, Agricultural Research Station, Raichur 584101, Karnataka, India.*
**Corresponding author E-mail*: mpratheepa@rediffmail.com

ABSTRACT: An attempt was made to study the effect of abiotic and naturally occurring biotic factors on *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) with cotton as a model crop system. The results revealed that *Chrysoperla* sp. (*carnea*-group) (r = 0.344) was positively correlated with pest incidence and the weather parameters like maximum temperature (r = -0.309) and rainfall (r = -0.288) were negatively correlated with pest incidence. It was observed that post-monsoon season was most favourable for pest occurrence and it was more when the crop was in flowering and boll formation stage. Spiders and *Chrysoperla* sp. (*carnea*- group) were positively correlated with pest incidence during winter.

KEY WORDS: *Helicoverpa armigera*, cotton, season, spiders, chrysopids

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INTRODUCTION

Cotton is an important cash crop and it is damaged by a large number of insect species, of which the cotton bollworm, *Helicoverpa armigera* (Hübner), is the most important. There is a need to study the factors influencing the pest population density in order to formulate effective pest management strategies. Pest population density can be influenced greatly by biotic and abiotic factors. These factors interact with each other and hence it is difficult to separate the influence of one weather variable from the other (Morton *et al*., 1981). Though attempts had been made to study the impact of abiotic factors and naturally occurring biotic factors on *H. armigera,* information is lacking on the seasonal pattern of abundance of the pest and its natural enemies on different crops in different areas under different situations. The estimates of population densities of pests and their natural enemies on different crop ecosystems during different seasons in different regions help to determine the response of the pest to various biotic and abiotic factors. Population densities of the pest and its natural enemies must be assessed in order to decide the control strategy for the pest. Hence, an attempt was made to do correlation analysis and regression model for finding the biotic and abiotic factors that can influence the pest population.

MATERIALS AND METHODS

The data sets were obtained from Regional Agricultural Research Station, Raichur, Karnataka, from the unsprayed experimental plots under AICRP on Bt-Cotton eco-system and the data sets obtained from non-Bt cotton plots taken for analysis. The sampling size was 25 plants / 500 sq. m area. Weekly observations on mean number of *H. armigera* larvae present per 5 plants were recorded for the period

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2005 to 2008. Natural enemies - spiders (NE1) and *Chrysoperla* (*carnea*-group) (NE2) per plant were recorded during this period. The weather parameters like maximum temperature (MaxT), mimimum temperature (MinT), relative humidity (RH) and rainfall (RF) were recorded based on weekly mean values. Pest incidence was related with previous week's abiotic and biotic factors for the analysis. In order to study the effect of biotic factors on the pest population, inter and intra-class correlation analyses were done among the pest incidence, natural enemies and weather factors by using Statistical Package for Social Science (SPSS V 17.0). Intra-class correlation was done to delineate the amalgamated role of several weather factors in describing the pest population.

The data were subjected to regression analysis (Ryan, 1997) and the equations along with Co-efficient of determination (R^2) and mean Square Error (MSE) (Kvalseth, 1985) determined. Statistical Package SPSS was extensively used in developing the prediction model.

RESULTS AND DISCUSSION

Correlation coefficients of pest incidence in relation to natural enemies and weather factors are shown in the Table 1. The data were pooled season-wise and the overall data were taken for correlation analysis. The results revealed that maximum temperature played a significant role and was inversely correlated with pest incidence during post-monsoon season. During winter, natural enemies – spiders and chrysopids were positively correlated with pest incidence. The overall results revealed that chrysopids positively correlated with pest incidence and maximum temperature and rainfall were negatively correlated with pest incidence. The data were subjected to regression analysis (Ryan, 1997) and the equations along with their Co-efficient of determination (R^2) values and Mean Square Error (MSE) (Kvalseth, 1985) are given in Table 2.

Table 1. Correlation coefficients of pest incidence related with natural enemies and weather factors

	Correlation coefficient (r)			
	Monsoon	Post-monsoon	Winter	Overall
NE1	–0.330	–0.312	0.621*	0.035
NE2	–0.050	0.059	0.800**	0.344**
MaxT	–0.396	–0.484**	–0.361	–0.309*
MinT	0.000	–0.008	0.289	–0.139
RF	–0.117	–0.079	–	–0.288*
RH	–0.023	–0.149	–0.087	–0.239

NE1 = spiders; NE2 = chrysopids; * = significant at $P \leq 0.05$ level; ** = significant at $P \leq 0.01$ level

The season-wise (monsoon, post-monsoon, winter and overall) regression analysis indicated that about 55, 50, 85 and 38% of the population fluctuations of *H. armigera* could be attributed to spiders and chrysopids and the weather factors like temperature, rainfall and relative humidity. The regression model for the overall season revealed that maximum temperature (MaxT) and relative humidity (RH) are negatively correlated with pest incidence. The mean values of maximum temperature, minimum temperature and relative humidity were 32.08ºC, 18.94ºC and 65.83%, respectively. The data set revealed that when the maximum temperature ranged from 29.9ºC to 34ºC, the pest incidence was the maximum and when the maximum temperatures rose above 34ºC, the pest incidence came down. These results were in conformity with earlier reports (Kumar and Kumar, 2001; Deshmukh *et al*., 2003; Dubey *et al*., 2004). Ballal (1998) also observed that the total *H. armigera* population showed a significant negative relationship with maximum temperature on sunflower during *kharif* season in unsprayed plots. Aheer *et al*. (2009) observed that the pest incidence was significantly correlated with maximum temperature under clean cultivation on cotton crop.

Table 2. Population prediction equation for *H. armigera*

Season / model	Regression equation	R^2	MSE
Monsoon	Y = 2.8 – 0.101 NE1 + 0.043 NE2 – 0.025 MaxT – 0.057 MinT – 0.008 RH	0.554	0.096
Post-monsoon	Y = 4.6 - 0.124 NE1 + 0.123 NE2 – 0.113 MaxT + 0.006 MinT – 0.009RH	0.506	0.251
Winter	Y = 1.1 + 0.040 NE1 + 0.116 NE2 – 0.04 MaxT + 0.042 MinT – 0.007 RH	0.857	0.092
Overall	Y = 3.7 – 0.087 NE1 + 0.139 NE2 – 0.09 MaxT + 0.02 MinT – 0.014 RH	0.386	0.260

Where Y = *H. armigera*; NE1 = spiders; NE2 = chrysopids; MaxT = maximum temperature; MinT = minimum temperature; = rainfall, RH = relative humidity

Season-wise regression analysis revealed that the pest incidence decreased during monsoon and post-monsoon seasons due to the occurrence of spiders. However, during winter, both spiders and chrysopids did not play a major role in controlling the pest. The pest incidence with host crop stages during the year 2005 to 2007 is presented in Fig. 1. The pest incidence started occurring at square initiation stage and reached peak during flowering and boll formation stage to boll maturity stage. The pest incidence was above the economic threshold level (ETL) of 1 larva / 10 plants most of the time [recorded at Bapatla (A.P.) by Dhaliwal and Arora (1996)].

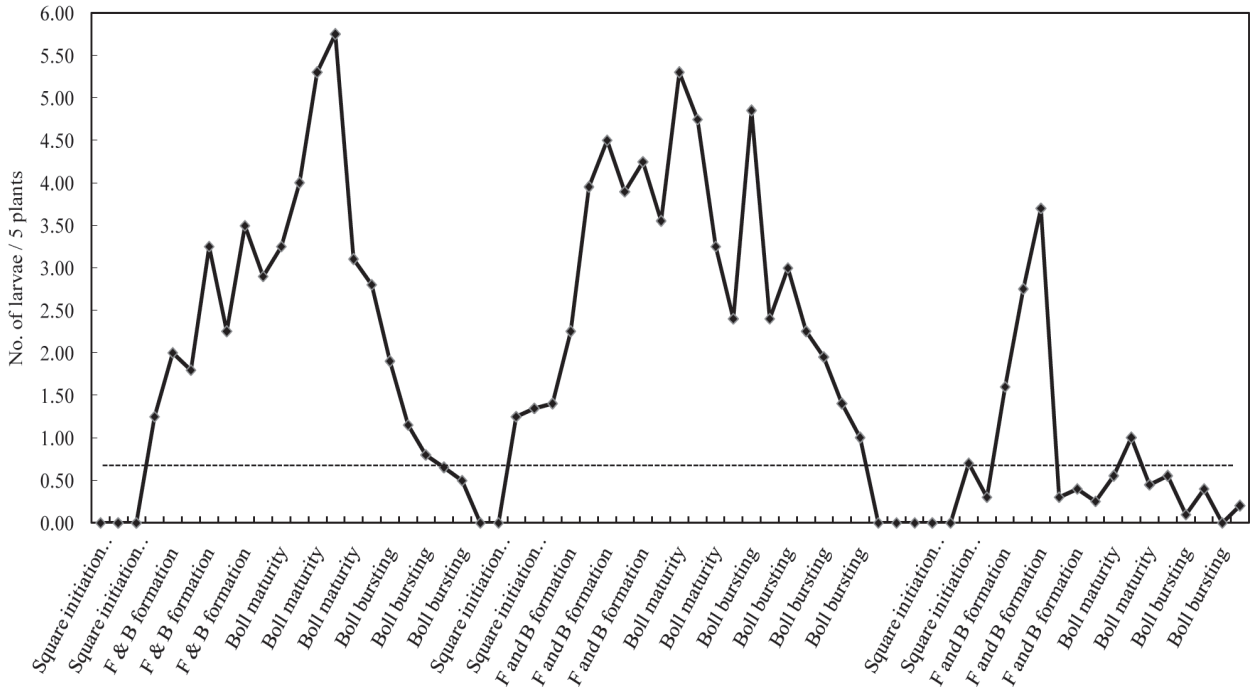

Fig. 1. Pest population at different stages of cotton crop [ETL - 1 larva / 10 plants (Bapatla, AP)]; F and B – Fruiting and boll formation stage)

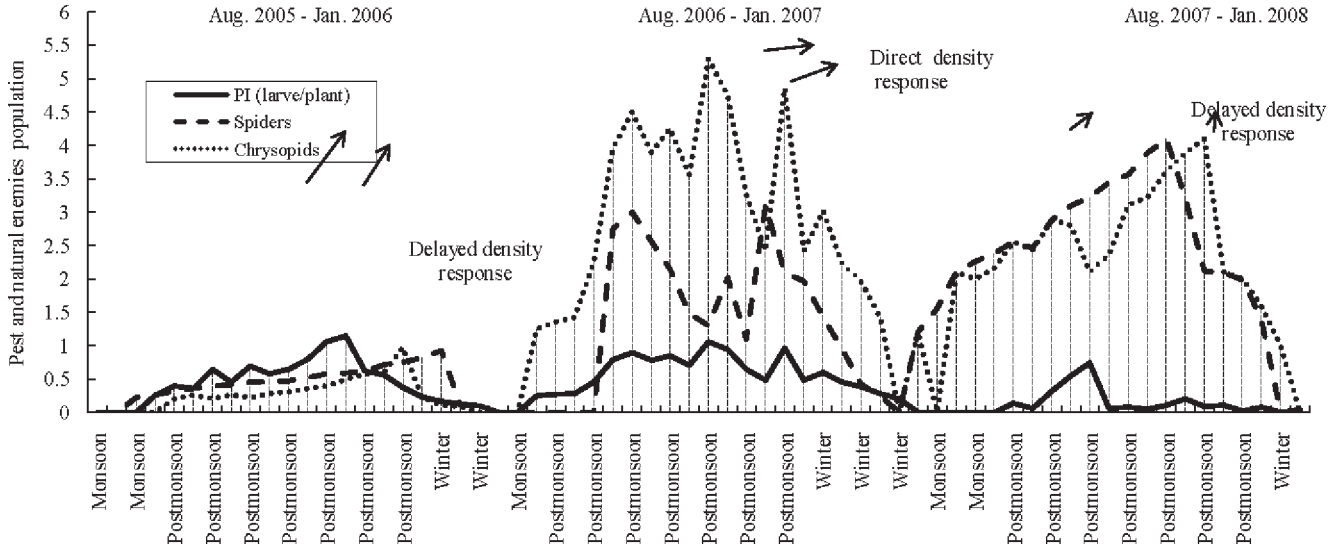

Fig. 2. Population of *H. armigera*, spiders and chrysopids in different seasons

The pest incidence and the occurrence of spiders and chrysopids during 2005-2007 is presented in Fig. 2. The pest incidence peaked in post monsoon season throughout the years. Similarly, spiders and chrysopids started occurring during monsoon and peaked in the post-monsoon season and showed downward trend in winter season. Kabissa *et al*. (1999) observed that *Chrysoperla* sp. occurred naturally on cotton when both *H. armigera* and *Aphis gossypii* Glover were present.

In the present study, it has been observed that at the beginning of the season during 2005-06, there was a delayed density response of natural enemies. However, during 2006-07 there was a direct density response and again delayed density response during 2007-08. The findings of the correlation analysis and regression model showed that post-monsoon season was more favourable for the pest incidence. Among all weather parameters, maximum temperature and rainfall played a significant role in

predicting pest incidence. Spiders and chrysopids were positively correlated with pest incidence on cotton during winter and overall, chrysopids were positively correlated with pest incidence.

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