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Durga Bahadur GM
Department of Entomology and Agricultural Zoology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Ram Keval
Department of Entomology and Agricultural Zoology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Sunil Verma
Department of Entomology and Agricultural Zoology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Kalpana Bisht
Department of Entomology and Agricultural Zoology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Correspondence
Durga Bahadur GM
Department of Entomology and Agricultural Zoology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Seasonal occurrence of gram pod borer [*Helicoverpa armigera* (Hubner)] on chickpea in Varanasi

Durga Bahadur GM, Ram Keval, Sunil Verma and Kalpana Bisht

Abstract
A study on the seasonal occurrence of *Helicoverpa armigera* on chickpea was studied at the Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi during two consecutive years of 2016-17 and 2017-18. The study revealed that the *H. armigera* marked its first appearance during the 2nd standard week with a population of 1.21 larvae per plant and persisted up to 11th SW with 3.67 larvae per plants. Similarly, during 2017-18, *H. armigera* started appearance during 3rd standard week population is 0.94 larval per plant and persisted up to 12th SW with 1.54 larval per plants. Correlation studies revealed that in the year 2016-17 there was positive association with maximum temperature (r = 0.636), sunshine (r= 0.595) wind velocity (r= 0.480) evaporation (r = 0.630) and minimum temperature (r =.0.580), whereas negative relationship was found with the morning relative humidity (r = -0.706*), evening relative humidity (r = -0.320) and rainfall (r= -0148), However, during the year 2017-18 there was positive association with maximum temperature (r = 0.463), minimum temperature (r =.0.562), rainfall (r= 000), sunshine (r= 0.449), wind velocity (r= 0.166) and evaporation (r = 0.834**). While negative non-significant relationship was found with the morning relative humidity (r = -0.399), and evening relative humidity (r = -0.761*).

Keywords: Chickpea, *Helicoverpa armigera*, seasonal incidence, standard week, correlation, abiotic and biotic factors

1. Introduction
Pulses, the food legumes, have been grown by farmers since millennia providing nutritionally balanced food to the people of India (Nene, 2006) [1] and many other countries in the world. In India, pulses have been described as a "poor man's meat and rich man's vegetable". The importance of vegetables protein has been well recognized throughout the world. India, with its predominantly vegetarian population, has a distinction of being the world's largest producer cum consumer of grain legumes and accounting for 28% of global production of pulses. In India pulses are grown in an area of 23.55 million hectares with total production of 17.15 million tonnes and productivity of 728 kg/ha (Anonymous, 2015) [2].
Chickpea (*Cicer arietinum* L.) is a legume crop of the Fabaceae family. It is also known as gram or Bengal gram, and it is commonly known as "King of Pulses" (Bakr *et al.* 2004) [3]. Chickpea is the third most important pulse crop in the world, after dry beans and field peas. Its grown under diverse agro ecological niches like rain fed /irrigated, mixed/ mono crop, early late mature group, low and high input condition, traditional/ progressive farming, etc (Lal and Ahmad 2001) [4]. Due to its high nutritional value crops forms an important component of the vegetarian diet and due to ability to fix the atmospheric nitrogen, gram is suitable for crop rotation (Kudale *et al.,* 2002) [5]. Grain legumes play an important role in overcoming the quantitative and qualitative protein requirement for large parts of humanity (Bhati and Patel, 2001) [6].
Chickpea is grown in different country of an area of 13.54 million ha with a production of 13.10 million tons and productivity of 968 kg ha^{-1}. The major chickpea producing countries are India (67.41%), Australia (6.21%), Pakistan (5.73%), Turkey (3.86%) and Myanmar (3.74%) (FAOSTAT, 2015) [7]. In India chickpea, is grown area is 8.95 million hectares with production 7.06 million tonnes and productivity 801 kg per ha. The highest production of chickpea in Maharashtra 7.76 lakh tonnes and productivity 539 kg per ha which covered nearly 14.52 lakh hectares of area.
Among biotic and abiotic stress, the major factor for low yields of chickpea is the damage caused by gram pod borer *Helicoverpa armigera* (Hubner) from vegetative to pod stage (Dhingra *et al.* 2003) [8].

However, chickpea is infested by near about 57 insect species and other arthropods (Lal, 1992) [9], but all are no of equal significance. *H. armigera* is reported to feed and breed on 182 species of host plants belonging to 47 families in India (Pawar, 1998) [10]. *H. armigera* is a charismatic and one of the most dominant insect pests in agriculture. The problem of this pest is magnified due to its direct attack on fruiting structures, voracious feeding habits, high mobility and fecundity, multivoltine nature, overlapping generations, nocturnal behavior, wide genetic diversity, an ability to withstand, metabolize and avoid toxic chemicals (Sarode, 1999) [11]. The population density of insect pests fluctuates when there is a change in weather conditions. Seasonal incidence is regulated by the abiotic factors such as temperature, rainfall, relative humidity, sunshine hours, wind velocity, etc. At the same time adequate ecological data is prerequisite for integrated pest management, which can therefore be enhanced after determining the seasonal abundance (Mathur *et al*. 2003) [12]. The knowledge on the seasonal incidence of gram pod borer will certainly be helpful and essential in developing integrated pest management systems with ecological and economical balance. With this aim the experiment was carried out to study the incidence of *H.* armigera on chickpea and to find out their correlation with the weather parameters.

2. Materials and Methods

BG 256 cultivar of chickpea was sown in 5 rows of 2 meters length with spacing of 30 cm (row to row) X 10 cm (plant to plant) in *Rabi* season for two consecutive years, i.e., 2016-17 and 2017-18. The crop was grown in Randomized Block Design following normal agronomic practices with three replications and five treatments. The observations on incidence of *H.* armigera on chickpea BG 256 was recorded by counting the number of larvae per plants weekly from appearance of *H. armigera* till harvesting of the crop, at 5 random places in each untreated plot. The mature as well as the immature stage of *H. armigera* were counted to record the incidence.

2.1 Statistical analysis

To established relationship between insect infestation and weather parameters, the insect infestation for a particular week was correlated with weather parameters lie rainfall maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, sunshine hours, wind speed and evaporation. Multiple regression analysis was also carried out. The metrological data was obtained from metrological observatory, Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi.

3. Results and Discussion

3.1 Seasonal incidence of *H. armigera* on chickpea

Data recorded on seasonal incidence of *H. armigera* during 2016-17 and 2017-18 are presented in the table 1 and table 2 or figure 1 and 2 respectively. During 2016-17, *H. armigera* marked its first appearance during 2nd SW with population of 1.21 larvae per plant and attained peak population of 8.83 larvae per plant in 7th SW. Thereafter, the population shows decreasing trend form 8th SW and persisted up to 11th SW with 3.67 larval per plants. Similarly, during 2017-18 *H. armigera* started its appearance during 3rd standard week with population of 0.94 larvae per plant, and attained peak population of 9.72 larvae per plant in 7th SW. Then the population shows decreasing trend form 10th SW and persisted up to 12th SW with 1.54 larvae per plants. The present findings are in collaboration with Reddy *et al.* (2009) [13] they found that incidence of *H. armigera* in chickpea commenced from second week of February i.e. in the early part of 1st fortnight of February with 0.05 larval population/ plant. The larval population started increasing and reached its maximum 12.9 larval population/ plant during 4th week of March.

3.2 Influence of weather parameters on the incidence of *H. armigera*

Simple correlation has been worked out between weather parameters and the incidence of Gram pod borer, *Helicoverpa armigera* during both the years, data related to correlations are depicted in table 3 and the study revealed that in the year 2016-17 there was positive significant association with maximum temperature (r = 0.636*), and positive non-significant association with minimum temperature (r =.0.580), sunshine (r= 0.595), wind velocity (r= 0.480) and evaporation (r = 0.630). Whereas, negative significant relationship was found with the morning relative humidity (r = -0.706*) and negative non significant correlation with evening relative humidity (r = -0.320), and rainfall (r= -0148). However, during the year 2017-18 there was positive non-significant association with maximum temperature (r = 0.463), and minimum temperature (r =.0.562), while negative non-significant relationship was found with the morning relative humidity (r = -0.399), and negative significant correlation with evening relative humidity (r = -0.761*), positive non-significant correlation was observed with rainfall (r= 000), sunshine (r= 0.449) and wind velocity (r= 0.166) whereas, positive significant correlation with evaporation and evaporation (r = 0.834**).

The multiple linear regression during both the years was worked out and presented in table 4 and table 5 respectively, indicated that all the weather parameters and larval incidence of *H. armigera* together was responsible for 94.00% (R^2 = 0.940) and 93.00% (R^2 = 0.930) during two consecutive years respectively. The regression equation revealed that the various abiotic factors were found to be most influencing factors for significant variation in the incidence of *H. armigera* in chickpea. The present findings are in partial accordance with Kumar *et al.* (2015) [14] they found that the larval population of *H. armigera* have positive correlation with maximum (r= 0.858) minimum (r= 0.886) and rainfall (r= 0.158) temperature while, relative humidity was found negative (r= -0.569).

Table 1: Weather parameters and population of gram pod borer, *H. armigera* on chickpea during *Rabi* 2016-17

S. No.	Month-date	Standard Week	Rainfall (mm)	Temperature (^{0}C)		Relative Humidity (%)		Sunshine (hours)	Wind velocity (km/hrs)	Evaporation (mm)	Mean larval population/plant
				Max.	Min.	Morning	Evening				
1	Jan 09-15	2	0.0	20.70	8.20	90	44	3.2	2.0	1.6	1.21
2	16-22	3	0.0	23.00	8.80	91	49	1.0	1.3	1.6	2.67
3	23-29	4	1.0	24.40	10.90	90	58	1.8	1.8	2.4	3.83
4	Feb 30-05	5	0.0	25.40	10.80	91	47	7.1	2.4	2.3	3.67
5	06-12	6	0.0	26.20	12.30	87	53	4.6	1.2	2.3	4.83
6	13-19	7	0.0	27.70	13.00	81	41	6.4	3.1	3.3	6.39
7	20-26	8	0.0	29.70	13.10	83	43	7.4	2.3	3.3	8.83
8	Mar 27-05	9	0.0	29.60	14.60	71	38	5.7	3.1	3.8	7.72
9	06-12	10	0.0	28.70	12.30	81	39	7.6	2.7	4.0	5.22
10	13-19	11	0.0	33.20	17.60	81	36	6.2	2.7	4.3	3.67

Table 2: Weather parameters and population of gram pod borer, *H. armigera* on chickpea during *Rabi* 2017-18

S. No.	Month-date	Standard Week	Rainfall (mm)	Temperature (^{0}C)		Relative Humidity (%)		Sunshine (hours)	Wind velocity (km/hrs)	Evaporation (mm)	Mean larval population/plant
				Max.	Min.	Morning	Evening				
1	Jan 15-21	3	0.0	26.30	7.00	91	62	9.3	1.4	1.7	0.94
2	22-28	4	0.0	22.70	8.20	91	64	8.7	2.7	2.3	1.61
3	29-04	5	0.0	24.70	10.20	93	74	7.6	2.0	2.3	2.33
4	Feb 05-11	6	0.0	27.60	10.90	66	54	7.0	2.8	2.2	3.22
5	12-18	7	0.0	31.80	12.80	93	53	10.4	1.5	2.8	5.72
6	19-25	8	0.0	29.20	17.50	61	49	10.2	1.8	3.6	8.77
7	26-04	9	0.0	28.60	15.90	85	38	9.1	2.7	4.5	9.72
8	Mar 05-11	10	0.0	37.70	17.51	84	56	9.8	2.7	5.3	7.5
9	12-18	11	0.0	28.80	17.40	80	44	7.1	3.2	4.0	5.11
10	19-25	12	0.0	34.14	15.63	73	26.71	8.78	1.77	4.84	1.54

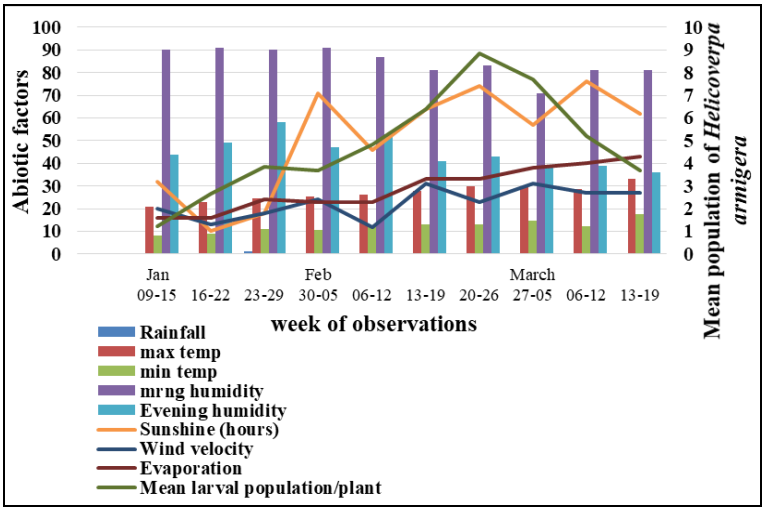

Fig 1: Seasonal incidence of pod borer, *H. armigera* on chickpea during Rabi 2016-17

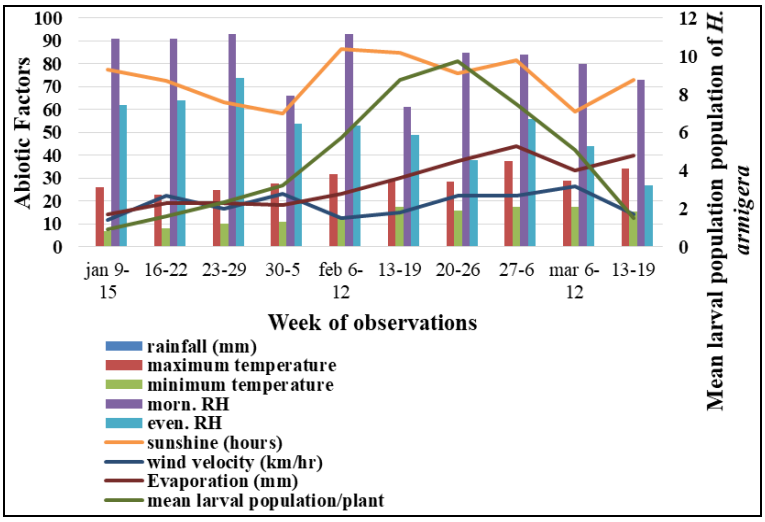

Fig 2: Seasonal incidence of pod borer, *H. armigera* on chickpea during Rabi 2017-18

Table 3: Correlation coefficients between weather parameters and larval population of *H. armigera* on chickpea (cv. BG 256) during *Rabi* 2016-17 and 2017-18

Weather Parameters	*H. armigera* population	
	2016-17	2017-18
Maximum temperature (ºC)	0.636*	0.463 ns
Minimum temperature (ºC)	0.580 ns	0.562 ns
Morning relative humidity (%)	- 0.706*	- 0.399 ns
Evening relative humidity (%)	- 0.320 ns	- 0.761*
Rainfall (mm)	- 0.148 ns	0.000 ns
Sunshine (hours)	0.595 ns	0.449 ns
Wind velocity (km/hr)	0.480 ns	0.166 ns
Evaporation (mm)	0.603 ns	0.834**

*****Correlation is significant at the 0.05 level (Two-tailed), **Correlation is significant at 0.01 level (Two-tailed), ns = non significant.

Table 4: Multiple regressions of *H. armigera* population with abiotic factors during *Rabi* 2016-17

Multiple regression	Temperature (º C)		Relative humidity (%)		Rainfall (mm) (X_5)	Sunshine hours (X_6)	Wind velocity (km/hr) (X_7)	Evaporation (mm) (X_8)
	Maximum (X_1)	Minimum (X_2)	Morning (X_3)	Evening (X_4)				
Coefficient	1.738	1.375	-0.454	-0.103	-2.715	0.480	0.390	4.045
Standard Error	1.018	0.915	0.223	0.397	6.782	0.746	3.006	3.792
T value	1.706	-1.503	-2.032	-0.260	0.400	0.644	0.130	-1.067
F value	1.967							
R^2	0.940							
Regression Equation	$Y_1 = 16.735 + 1.738 (X_1) + 1.375 (X_2) – 0.454 (X_3) – 0.103 (X_4) – 2.715 (X_5) + 0.480 (X_6) + 0.390 (X_7) + 4.045 (X_8)$							

Table 5: Multiple regressions of *H. armigera* population with abiotic factors during Rabi 2017-18

Multiple regression	Temperature (º C)		Relative humidity (%)		Rainfall (mm) (X_5)	Sunshine hours (X_6)	Wind velocity (km/hr) (X_7)	Evaporation (mm) (X_8)
	Maximum (X_1)	Minimum (X_2)	Morning (X_3)	Evening (X_4)				
Coefficient	0.096	0.185	-0.066	-0.122	0.000	2.390	0.261	2.949
Standard Error	0.341	0.352	0.092	0.124	0.000	3.282	1.530	2.576
T value	-0.281	-0.524	-0.719	-0.921	0.000	-0.728	-0.178	1.145
F value	1.894							
R^2	0.930							
Regression Equation	$Y_1 = 16.735 + 0.096 (X_1) + 0.185 (X_2) – 0.066 (X_3) – 0.122 (X_4) + 0.000 (X_5) + 2.390 (X_6) + 0.261 (X_7) + 2.949 (X_8)$							

Y_1 = *H. armigera* population, X_1= Maximum temperature (ºC), X_2 = Minimum temperature (ºC), X_3 = Morning relative humidity (%), X_4 = Evening relative humidity (%), X_5 = Rainfall (mm), X_6 = Sunshine (hours), X_7 = Wind velocity (km/hr), X_8 = Evaporation (mm)

4. Conclusion

The present study revealed that the incidence or activity of *H. armigera* in Varanasi region is commenced from 2nd standard week and population builds up continues till 12th standard week and population is influenced by the various abiotic factors. Weather parameters and larval incidence of *H. armigera* together was responsible for 94.00% (R^2 = 0.940) and 93.00% (R^2 = 0.930) during two consecutive years respectively.

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