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Relationship between Weather Parameters and Incidence of Gram Pod Borer, *Helicoverpa armigera* on Chickpea

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ABSTRACT

Background: Chickpea, *Cicer arietinum* which is considered as a "King of pulses" get adversely affected by several biotic and abiotic stresses, out of which gram pod borer, *Helicoverpa armigera* (Hübner) is the major one. The damage caused by *H. armigera* starts from vegetative growth and continues till maturity of the crop. This pest is causes 25 to 70 per cent pod damage in chickpea but in favorable conditions pod damage goes upto 95 per cent.

Methods: Present study was carried out during, *rabi,* 2014-15 and 2015-16 at Research Farm, College of Agriculture, Bikaner (Rajasthan). Correlation coefficient was worked out with weather parameters such as temperature (maximum and minimum), relative humidity (maximum and minimum), rainfall and sunshine hours. Multiple linear forms of regression model were also used to assess the effect of the weather parameters on the incidence of pod borer.

Result: The studies revealed that peak larval population of gram pod borer was recorded in the second fortnight of February thereafter, population declined abruptly. The larval population of pod borer on chickpea occurred low at vegetative and flowering stages and high at pod formation as well as at grain developmental stages. The temperature (maximum and minimum) and sunshine hours had significant positive correlation with larval population during *rabi,* 2015-16. The maximum relative humidity showed significant negative correlation during *rabi,* 2015-16 whereas, minimum relative humidity showed significant negative correlation with larval population during both the seasons. The rainfall showed significant positive correlation during *rabi*, 2014-15.

Key words: Chickpea, Correlation, Gram pod borer, Population, Weather parameters.

INTRODUCTION

Chickpea, *Cicer arietinum* (L.) also known as gram or Bengal gram belongs to the family leguminosae. It is one of the most important and remunerative pulse crop of *Rabi* season, grown around the world. Although all the pulses occupy a unique position in Indian agriculture as well as in the world but chickpea is considered as "king of pulses". The productivity of chickpea is adversely affected by several biotic and abiotic stresses, out of which gram pod borer, *Helicoverpa armigera* (Hubner) is the major one. The damage caused by *H. armigera* starts from vegetative growth and continues till maturity of the crop (Dhingra *et al.,* 2003). It is a very serious pest and has assumed the status of national pest in India because of its high fecundity, migratory behavior, cosmopolitan distribution, high adaptation to various climatic conditions and development of resistance to a wide range of insecticides (Gowda, 1996). Although it attacks chickpea throughout the crop growth, the damage caused during flowering and pod formation stages results in substantial yield loss. A single larva alone can destroy 30-40 pods before the maturity (Reed and Pawar, 1982). In Rajasthan, *H. armigera* caused 19-20 per cent reduction in grain yield of gram (Ameta and Thakar, 1988). The studies were undertaken to find out the correlation coefficient along with regression equation between pest population and key weather parameters to know the most favourable conditions.

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MATERIALS AND METHODS

The experiment was conducted at Research Farm, College of Agriculture, Bikaner (Rajasthan) to study the relationship between weather parameters and incidence of *H. armigera* on chickpea, the variety GNG-1581 was sown on 15th October during *rabi,* 2014-15 and on 17th October during *rabi,* 2015-16 in a plot of 10×10 m^2. The row to row and plant to plant distance of 30 and 10 cm was maintained, respectively. Population of *H. armigera* was recorded at weekly intervals on chickpea. The observations on the incidence of *H. armigera* infesting chickpea were recorded by counting the larval population per meter row length from five randomly selected spots in the plot.

Correlation coefficient was worked out with weather parameters such as temperature (maximum and minimum), relative humidity (maximum and minimum), rainfall and sunshine hours. Following formula was used for calculating correlation coefficient.

$$rX_1Y_1 = \frac{\Sigma X_1Y_1 - \frac{\Sigma X_1 \Sigma Y_1}{n}}{\sqrt{\left[\Sigma X_1^2 - \frac{(\Sigma X_1)^2}{n}\right]\left[\Sigma Y_1^2 - \frac{(\Sigma Y_1)^2}{n}\right]}}$$

Where,
rX_1Y_1= Simple correlation coefficient.
X_1= Independent variable *i.e.* abiotic component.
Y_1= Dependent variable *i.e.* pest.
n= Number of observations.

Multiple linear forms of regression model was also used to assess the effect of the weather parameters on the incidence of pod borer.

$$Y = a + b_1 X_1 + b_2 X_2 + \ldots\ldots\ldots\ldots\ldots + b_5 X_5 + Ui$$

Where,
Y = Larval population of *H. armigera*.
a = Constant.
x_1 = Maximum temperature (°C).
x_2 = Minimum temperature (°C).
x_3 = Maximum relative humidity (%).
x_4 = Minimum relative humidity (%).
x_5 = Rainfall (mm).
x_6 = Sunshine hours (hrs).
Ui= Error term.

RESULTS AND DISCUSSION

Effect of weather parameters on the incidence of *H. armigera*

The data presented in Table 1 and Fig 1,2 revealed that the larval population of *H. armigera* first appeared in the third and fourth week of January during *rabi,* 2014-15 and 2015-16, respectively. Initially only 0.3 and 0.9 larva per meter row length (mrl) were recorded during *rabi*, 2014-15 and 2015-16, respectively. The present results are in agreement with those of Lal (1996); Reddy *et al*. (2009) and Dhaka *et al*. (2011), who reported activity of larvae of *H. armigera* during the months of January and February. The larval population increased gradually after appearance with the vegetative growth of the chickpea and attained its peak in the fourth week of February (5.8 larvae per mrl) during *rabi*, 2014-15 and third week of February (6.0 larvae per mrl) during *rabi*, 2015-16; there after, population declined abruptly. The results corroborate the findings of Gupta and Chandel (2008); Dhaka *et al.* (2011); Pandey *et al.* (2012); Sharma *et al.* (2012) and Shinde *et al.* (2013) who reported peak period of larval infestation in last week of February and beginning of March.

Correlation between weather parameters and larval population of *H. armigera*

The correlation studies (Table 2) revealed that during first year (*rabi,* 2014-15) the larval population showed non-significant positive correlation with maximum temperature and minimum temperature (r=0.022 and 0.163, respectively). These results corroborates with findings of Krishna *et al.* (2007); Gupta and Chandel (2008); Reddy *et al.* (2009); Sharma *et al.* (2012) and Mahawar *et al.* (2015), who reported positive non-significant correlation with larval population and temperature. During second year (*rabi,* 2015-16), the significant positive correlation was also existed between larval population and maximum and minimum temperature (r=0.884 and 0.898). Kulhari and Singh (2008); Pandey *et al.* (2012); Shinde *et al.* (2013) and Yadav *et al.* (2016) also computed significant positive correlation between larval population and temperature, which supports the present findings.

Maximum relative humidity showed negative non-significant (r=-0.110) and significant correlation (r=-0.761) with larva population during first and second year, respectively, while minimum relative humidity showed significant negative correlation during both the years (r=-0.588 and -0.582, respectively). The present finding confirms with the results

Table 1: Incidence of *H. armigera* on chickpea during *rabi,* 2014-15 and 2015-16.

SMW*	Month and week	Mean larval population per meter row length	
		2014-15	2015-16
3	January III	0.3	0.0
4	January IV	0.6	0.9
5	January V	1.3	1.8
6	February I	1.9	2.5
7	February II	2.7	4.1
8	February III	3.4	6.0
9	February IV	5.8	4.9
10	March I	4.1	3.7
11	March II	3.2	2.6
12	March III	2.1	1.2
13	March IV	0.8	0.6
14	April I	0.0	0.0

*SMW: Standard meteorological week.

Table 2: Correlation between larval population of *H. armigera* and weather parameters.

Abiotic factors	Correlation coefficient (r)	
	2014-15	2015-16
Temperature (°C)		
a. Maximum	0.022 NS	0.884**
b. Minimum	0.163 NS	0.898**
Relative humidity (%)		
a. Maximum	-0.110 NS	-0.761**
b. Minimum	-0.588*	-0.582*
Rainfall (mm)	0.807**	0.115 NS
Sunshine (hrs)	0.010 NS	0.868 **

*Significant at 5% level of significance, **Significant at 1% level of significance, NS: Non-significant.

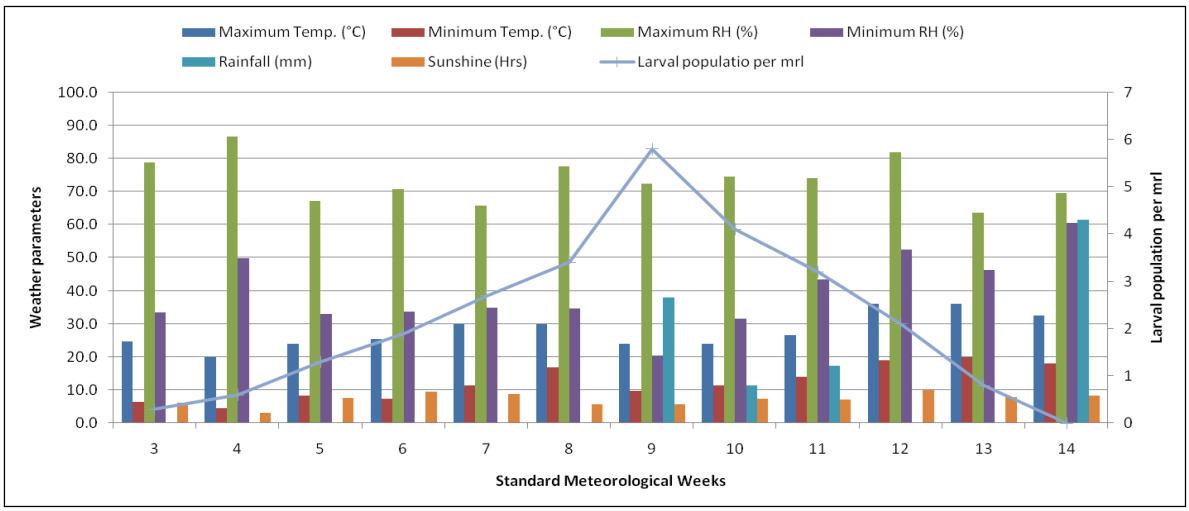

Fig 1: Seasonal incidence of *Helicoverpa armigera* on chickpea during *rabi*, 2014-15.

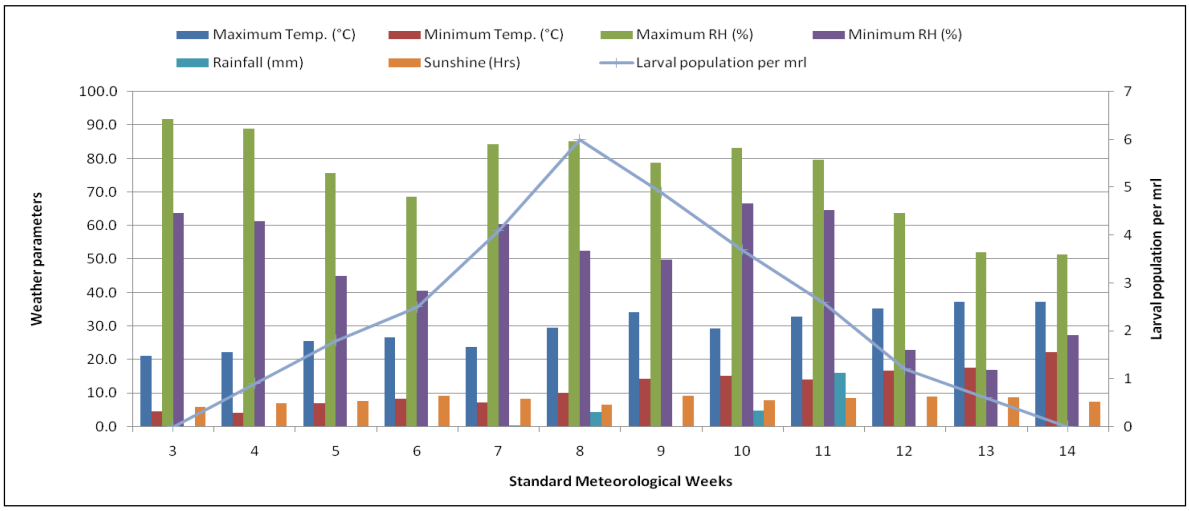

Fig 2: Seasonal incidence of *Helicoverpa armigera* on chickpea during *rabi*, 2015-16.

Table 3: Regression analysis between larval population of *H. armigera* and weather parameters.

Year	Regression equation	R^2	R
2014-15	$Y= 2.374-0.286T_{max}+0.390T_{min}+0.094RH_{max}-0.152RH_{min}+0.015RF+0.260SSH$	0.813	0.902
	$Y= 3.630-0.176T_{max}+0.328T_{min}+0.072RH_{max}-0.154RH_{min}+0.016RF$	0.777	0.882
	$Y= 5.798-0.247T_{max}+0.390T_{min}+0.056RH_{max}-0.143RH_{min}$	0.754	0.868
	$Y= 11.611-0.410T_{max}+0.355T_{min}-0.033RH_{max}$	0.240	0.489
	$Y= 8.733-0.390T_{max}+0.348T_{min}$	0.225	0.475
	$Y= 3.986-0.065T_{max}$	0.037	0.193
2015-16	$Y= -24.278+0.426T_{max}-0.168T_{min}+0.128RH_{max}+0.043RH_{min}-0.095RF+0.567SSH$	0.522	0.722
	$Y= -21.609+0.662T_{max}-0.367T_{min}+0.057RH_{max}+0.098RH_{min}-0.140RF$	0.472	0.687
	$Y= -18.194+0.458T_{max}-0.224T_{min}+0.113RH_{max}+0.023RH_{min}$	0.436	0.660
	$Y= -18.847+0.417T_{max}-0.171T_{min}+0.144RH_{max}$	0.432	0.657
	$Y= -1.390+0.227T_{max}-0.251T_{min}$	0.055	0.235
	$Y= 2.644-0.010T_{max}$	0.001	0.028

Where, Y= Larval population of *H. armigera*; T_{max}= Maximum temperature (°C); T_{min}= Minimum temperature (°C); RH_{max}= Maximum relative humidity (%); RH_{min}= Minimum relative humidity (%); RF= Rainfall (mm); SSH = Sunshine hours (Hrs).

of Pandey *et al.* (2012) and Sharma *et al.* (2012) they recorded negative non-significant correlation between larval population and relative humidity. Umbarkar *et al.* (2010); Wakil *et al.* (2010) and Mahawar *et al.* (2015) computed negative significant positive correlation with larval population and relative humidity; these findings are also supports present findings.

Rainfall showed significant and non-significant positive correlation (r=0.807 and 0.115) with larva population during first and second year, respectively. The present results corroborates with the findings of Gupta and Chandel (2008); Kulhari and Singh (2008) and Kumar *et al.* (2015), who also found positive non-significant correlation between larval population and rainfall.Sunshine hours showed non-significant and significant positive (r=0.010 and 0.868) correlation during first and second year, respectively. Mahawar *et al.* (2015) recorded positive non-significant correlation with sunshine hours and larval population which supports the present findings.

Regression analysis between larval population of *H. armigera* and weather parameters

The regression equation was computed by taking of larval population of pod borer as dependent variable and other weather parameters as independent variable. It was evident from the study that none of the weather parameters were alone responsible for larval population of pod borer on chickpea (Table 3). All weather parameters collectively accounted for 81.30 and 52.20 per cent variability in larval population of pod borer during 2014-15 and 2015-16, respectively.

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