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Research Journal of Agricultural Sciences
An International Journal

P- ISSN: 0976-1675
E- ISSN: 2249-4538

Volume: 12
Issue: 04

Res Jr of Agril Sci (2021) 12: 1454–1457

CARAS

Res. Jr. of Agril. Sci. (July-Aug 2021) 12(4): 1454–1457
www.rjas.org

Full Length Research Article

Influence of Environmental Factors on Population of Chickpea Pod Borer, *Helicoverpa armigera* (Hub.) in Chickpea Spatial

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Received: 30 May 2021 | Revised accepted: 25 Jul 2021 | Published online: 23 Aug 2021

ABSTRACT

An experiment was conducted at Agricultural Research farm of Brahmanand P.G. college, Rath, Hamirpur, U.P. during 2016-17 and 2019-20 cropping season. It was observed that the infestation of chickpea pod borer (*Helicoverpa armigera* Hub.) was initiated from 51st SW (third week of December) with minimum population (0.33 larva^{-mrl}) during both cropping season. Its population growth pattern showed two peaks first on 3rd SW (third week of January) i.e., 1.33 larvae and 2.00 larvae^{-mrl} respectively on 2016-17 and 2019-20 and second peak on 11th SW (third week of March) i.e., 3.67 larvae^{-mrl} during both cropping seasons. Thereafter, its population decline gradually to reach 0.33 larva^{-mrl} during 2016-17 at 13th SW (last week of March), while during 2019-20 its population was negligible at 13th SW. The maximum and average temperature had significant positive correlation with population dynamics of *Helicoverpa armigera*, while minimum temperature, maximum and minimum relative humidity and rainfall were negatively correlated with population dynamics of *Helicoverpa armigera* during 2016-17. Whereas, during 2019-20 cropping season relative humidity (maximum and minimum) had negative correlation and temperature (maximum, minimum and average) and rainfall had positive correlation with population buildup of *Helicovera armigera.*

***Key words*:** *Helicoverpa armigera,* Environmental factors, Chickpea

Chickpea (*Cicer arietenum* (L) is a most important pulse crop of India which is mostly grown under dry land condition with heavy cloudy soil. India rank first in the production and consumption of chickpea in the world, but in the case of productivity per hectare India's rank is very poor owing to various biological and environmental factors. Among biological constraints gram pod borer (*Helicoverpa armigera* (Hub.) is major bottleneck in reducing the per hectare productivity of chickpea. Among environmental factors the 0.1°C increase in maximum and minimum temperature may reduce 38.49 and 13.46 Kg/ha grain yield of chickpea. However, reduction in every 10 mm rainfall reduce the 12.35 Kg/ha production of chickpea [1].

Pulses are rich source of protein and hence are highly conducive for infestation of insect pests. Gram pod borer (*H. armigera*) is the main constraints of chickpea which limit their production [2]. It has a wide host range and feeds on more than 250 crop species with different names i.e., gram pod borer, tomato fruit borer, American boll worm, maize corn borer etc. [3]. The gram pod borer begins infestation at the seedling stage and later feed on the flower and developing seeds in peak until crop maturity [4]. It has been reported as prolific pest of chickpea and caused yield loss mainly due to pod damage which range from 14-38 per cent, whereas, if the environmental conditions are congenial to *Helicoverpa armigera* then pod damage goes upto 90-95 percent [5].

The environmental factors also influence the survival and reproductive potential of insect pests. In favourable environmental condition the population density of *H. armigera* is the highest and cause severe crop losses. Hence, the knowledge of relationship between environmental factors and population density of *Helicoverpa armigera* play important role for its ecofriendly management. Hence, an attempt has been made to ascertain the influence of environmental factors on the population dynamics of *Helicoverpa armigera* in Bundelkhand region of Uttar Pradesh.

MATERIALS AND METHODS

The investigation of influence of meteorological factors on population dynamic of chickpea pod borer (*H. armigera*) in chickpea (*Cicer arietinum*) was conducted during 2016-17 and 2019-20 cropping season at Agricultural Research Farm of Brahmanand P.G. College, Rath,

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Hamirpur, U.P. The chickpea cultivar Radhey was sown in the plots size of 5mx3m during the second fortnight of October 2016-17 and 2019-20. The larval population of *Helicoverpa armigera* was recorded at weekly intervals throughout the cropping season from per meter row length selected randomly in three times from each plot. The population of gram pod borer larvae were counted by direct visual counting method and their mean population at different standard meteorological week were used for correlation and regression analysis with various meteorological factors by following standard statistical formula given by Karl Pearson.

$$r = \frac{\sum xy - \frac{\sum x \cdot \sum y}{N}}{\sqrt{\{\sum x^2 - \frac{(\sum x)^2}{N}\}\{\sum y^2 - \frac{(\sum y)^2}{N}\}}}$$

Where;
r= Co-efficient of correlation
N= Number of observation
X= Mean Population
Y= Independent variable

Then the correlation co-efficient(r) was tested for significance or non-significance by Fisher 't' which is defined as follows:

$$t = \frac{r}{\sqrt{1-r2}}\sqrt{n-2}\ \text{With}(n-2)\text{d.f}$$

For calculation of simple and multiple correlation coefficients the weekly average values of meteorological factors were taken into consideration to know their influence on chickpea pod borer population.

RESULTS AND DISCUSSION

Chickpea pod borer (*Helicoverpa armigera*) was observed as major insect pests of chickpea to infest both in vegetative and reproductive growth phase of the crop. The appearance of *H. armigera* larvae were first noticed on 51th SW (third week of December) with lowest population density (0.33 larva^{-mrl}) during 2016-17 and 2019-20 cropping season. Thereafter its population increase gradually to reach first peak 1.67 larvae^{-mrl} on 02 SW (second week of January) and 3rd week of January (2.00 larvae^{-mrl}) during 2016-17 and 2019-20 (Table 1-2). After that its population declined gradually and again increase from 0.33 (4th SW) and 1.00 (5th SW) larva^{-mrl} to reached its second peak 3.33 larvae^{-mrl} (10th SW) and 3.67 larvae^{-mrl} (11th SW), respectively during both the cropping season. Thus, the population of chickpea pod borer larvae had slight reduction in 4th and 5th standard meteorological week. It was seeming due to reduction in temperature (maximum, minimum and average) and increase in relative humidity (maximum and minimum) prior or during the observation date. The various findings on incidence and population density of *Helicoverpa armigera* is corroborated with [6] who observed that *Helicoverpa armigera* was active from 10th SW to 15th SW and Maximum population density observed on 13th SW. While, [7] reported peak incidence of *Helicoverpa armigera* on chickpea at 52nd SW (1.2 larvae/plant). Maximum incidence of *Helicoverpa armigera* with the mean population of 14.55/ 10 plants during third week of March, thereafter population declined with the maturity of pod [8]. In another report made by [9] observed that the *Helicoverpa armigera* larval population was active on chickpea from 50th SW to 16th SW with a peak in 13th SMW.

Table 1 Influence of meteorological factors on population of chickpea pod borer (*Helicoverpa armigera*) in chickpea during 2016-17

S. No.	SW	Larval population / meter row length	Weather parameters					Rainfall
			Temperature (°C)			Relative humidity		
			Max.	Min.	Average	Max.	Min.	
1	48	0.00	29.0	11.8	20.4	87	50	0
2	49	0.00	23.8	9.6	16.7	92	56	0
3	50	0.00	26.7	8.9	17.8	86	46	0
4	51	0.33	25.8	7.4	16.6	87	52	0
5	52	0.67	25.5	8.0	16.75	88	62	0
6	1	1.33	21.0	7.8	14.4	91	69	0
7	2	1.67	19.7	6.0	12.85	91	77	3.6
8	3	1.33	20.6	6.4	13.5	90	58	0
9	4	0.33	24.4	9.5	16.95	89	53	22.2
10	5	1.00	23.3	10.0	16.65	91	57	0
11	6	1.33	24.4	8.7	16.55	89	54	0
12	7	2.00	25.5	9.6	17.55	87	46	0
13	8	2.33	30.0	10.6	20.3	81	41	0
14	9	3.00	29.7	11.5	20.6	80	43	0
15	10	3.33	28.1	10.9	19.5	76	44	0
16	11	3.67	28.7	10.5	19.6	80	35	0
17	12	1.00	33.8	16.1	24.95	80	37	0
18	13	0.33	38.7	18.8	28.75	69	31	0

*SW- standard week

Table 2 Influence of meteorological factors on population of chickpea pod borer (*Helicoverpa armigera*) in chickpea during 2019-20

S. No.	SW	Larval population / meter row length	Weather parameters					Rainfall
			Temperature (°C)			Relative humidity		
			Max.	Min.	Average	Max.	Min.	
1	48	0.00	27.2	12.4	19.8	87	59	0
2	49	0.00	24.1	8.8	16.45	89	55	0
3	50	0.00	23.1	10.7	16.9	88	68	6.2
4	51	0.33	20.5	5.7	13.1	91	68	0
5	52	1.00	15.9	4.2	10.05	95	76	2
6	1	1.67	18.4	7.5	12.95	91	68	0.6
7	2	1.33	21.1	5.9	13.5	86	62	0.4
8	3	2.00	18.3	7.8	13.05	92	73	23.6
9	4	1.67	22.8	7.1	14.95	86	52	0
10	5	1.00	23.0	7.8	15.4	85	50	0
11	6	1.67	22.0	6.2	14.1	86	53	0
12	7	2.00	26.3	9.8	18.05	82	42	0
13	8	2.33	26.5	11.8	19.15	85	52	0
14	9	2.67	28.1	12.6	20.35	83	51	0
15	10	3.00	27.2	13.2	20.2	84	46	2.6
16	11	3.67	27.1	12.8	19.95	81	48	0
17	12	1.30	31.8	14.6	23.2	76	44	6.2
18	13	0.00	32.0	16.8	24.4	77	41	3.2

*SW- standard week

Table 3 Correlation coefficient and regression between larval population of *Helicoverpa armigera* and weather parameters during 2016-17

Insect name	Weather parameters		r	r^2	Regression equation
Helicoverpa armigera	Temp.	Max.	.04377	.0019	Y= (1.0309) + (.0107)x
		Min.	-.03767	.0014	Y= (1.4557) + (-.0138)x
		Average	.01132	.0001	Y= (1.2540) + (.0034)x
	RH	Max.	-.35910	.1290	Y= (6.9792) + (-.0665)x
		Min.	-.24034	.0578	Y= (2.5097) + (-.0236)x
	Rainfall		-.19122	.0366	Y= (1.3764) + (-.0421)x
H. armigera + Max Temp + Min Temp + Max RH + Min RH + Rainfall			.7803	.6089	Y= a+b+c+d+e+fx Y= (38.4715) + (.0328) + (.0597) + (.2638) + (-.0022) + (-.4357)x

*Test of significance at 5% level (Y= a+bx)

Table 4 Correlation coefficient and regression between larval population of *Helicoverpa armigera* and weather parameters during 2019-20

Insect name	Weather parameters		r	r^2	Regression equation
Helicoverpa armigera	Temp.	Max.	.08922	.0080	Y= (.8953) + (.0219)x
		Min.	.12338	.0152	Y= (1.0486) + (.0385)x
		Average	.10641	.0113	Y= (.9182) + (.0298)x
	RH	Max.	-.21653	.0469	Y= (5.5358) + (-.0479)x
		Min.	-.28375	.0805	Y= (3.0316) + (-.0287)x
	Rainfall		.02636	.0007	Y= (1.3764) + (-.0421)x
H. armigera + Max Temp + Min Temp + Max RH + Min RH + Rainfall			.5728	.3281	Y= a+b+c+d+e+fx Y= (38.4715) + (.0328) + (.0597) + (.2638) + (-.0022) + (-.4357)x

*Test of significance at 5% level (Y= a+bx)

The larval population of *Helicoverpa armigera* on chickpea was active from 51st SMW to 13th SMW with peak on 11th SW (3.67 larvae^{-mrl}) during 2016-17 and in 2019-20 its activity was recorded from 51st SMW to 12th SMW with a peak in 3.67 larvae^{-mrl} on 11th SMW. The population build up pattern showed increasing trend from their incidence to the maturity of crop. It was mainly due to increasing trends of maximum and average temperature which had positive correlation with population density of *Helicoverpa armigera*. However, an increase in average temperature and a reduction in the relative humidity from 5th SMW to 13th SMW (from February to third week of March) the larval population of *Helicoverpa armigera* increase gradually and with maturity of the crop the larval population has been observed to decline. The similar observation made by earlier entomologist [10-11] reported that larval population of *Helicoverpa armigera* had significant positive correlation with mean atmospheric temperature. While, [12-13] observed positive correlation between both minimum and maximum temperature and population density of

Helicoverpa armigera. While, in the present investigation the larval population of *Helicoverpa armigera* had negative correlation with maximum relative humidity (r=-0.3591 and -0.2165 and r^2=0.0579 and 0.0469) and minimum relative humidity (r=-0.2403 and -0.2836 and r^2=0.0366 and 0.0805) respectively, during 2016-17 (Table 3) and 2019-20 (Table 4). During 2016-17 cropping season minimum temperature had negative correlation coefficient (r=-0.03767, r^2=0.0014) with larval population of *Helicoverpa armigera*. The earlier similar findings made by [14] who observed negative and non-significant correlation between population dynamics and relative humidity.

CONCLUSION

In Bundelkhand agro climatic zone of Uttar Pradesh chickpea is major pulse crop and gram pod borer is major insect–pest. The activity of gram pod borer in chickpea crop started from vegetative stage and cause severe damage at reproductive stage of crop. The knowledge on influence of environmental factors on population dynamic of pod borer larvae plays important role on their forecasting and implementation of IPM program for their management. The peak population of *Helicoverpa armigera* was observed at second and third week of March. The maximum and average temperature and all the environmental factors (multiple correlation) had significantly positive correlation while, relative humidity (maximum and minimum) had significantly negative correlation with larval population of *Helicoverpa armigera*. All the environmental factors (regression coefficient) influenced 60.89% and 32.81% population of gram pod borer larvae.

Acknowledgement

The research paper is part of Ph. D. thesis of Hari Prakash Namdev. The author is grateful to Principal Brahmanand P. G. college, Rath, Hamirpur (U.P.) for providing of Laboratory, Library and research field facilities. The author also oblige to Ph. D. research cell of Bundelkhand University, Jhansi for their valuable support and guidance.

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