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Effect of certain weather parameters on population fluctuation of gram pod borer (*Helicoverpa armigera* Hubner) in chickpea

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Abstract
Chickpea is the major pulse crop grown in India and it is major protein source for many Indians. It is subjected to severe damage by pod borer, *Helicoverpa armigera* (Hubner) which causes yield loss of 400 kg/ha. *H. armigera* is a polyphagous pest with wide host range and is subjected to heavy insecticidal sprays in various crops. The climatic factors like rainfall, temperature, humidity and sunshine hours mainly influence the abundance of *H. armigera*. During 2015-16 and 2016-17, a bulk chickpea plot of 100m^2 was raised at Institute of Agricultural Sciences, BHU, Varanasi. The experimental plot was maintained without any insecticidal sprays and the number of *H. armigera* larvae was counted randomly from 10 plants on standard week interval basis. During 2015-16 and 2016-17, *H. armigera* larval population was first observed on 4th standard week (Jan 22-28). A peak larval population was observed on 9th standard week (9.31 larvae per 10 hills) and 10th standard week (9.87 larvae per 10 hills) during 2015-16 and 2016-17, respectively. The larval population was observed in the field till the maturity of the crop. Correlation studies revealed that the *H. armigera* larval population was correlated as significantly positive with sunshine hours during 2015-16 and 2016-17. Maximum and minimum temperature had a positive non significant correlation with larval population during both years of experimentation. Further, rainfall, morning relative humidity and evening relative humidity were observed to be non significantly correlated with *H. armigera* larval population.

Keywords: Chickpea, abiotic factors, *H. armigera* and correlation

Introduction

Chickpea is a legume plant of family Fabaceae. It was one of the first grain legume to be domesticated in Old world and South eastern Turkey is the center of origin (Vander maesen, 1987) [1]. The word ‘chickpea’ is derived from French ‘Ciche’. It is also known as gram, Bengal gram, garbanzo bean. It is one of the major pulse crop grown in India. Chickpea is herbaceous annual plant with height ranging between 30-70 cm. It has tap root system bearing symbiotic nodules with Rhizobium bacteria which are capable of fixing atmospheric nitrogen in plant usable form. It is suited to areas having relatively cooler climatic conditions and low rainfall. It is grown in a wide range of soils but soils with appropriate drainage system are best to achieve higher yield (Anonymous, 2016) [2]. *Helicoverpa* armigera (Hubner) is a one of the most dominant insect pests in agriculture, accounting for half of the total insecticides usage in India for protection of crops. 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 behaviour *etc.*, (Sarode, 1999) [3]. In chickpea, it feeds on pods reducing yield by 21 per cent (Kumar and Smithson, 1980) [4] and 37-50 per cent (Khan and Faizullah, 1999) [5]. Chaudhry and Sharma (1982) [6] reported that a single larva of *H. armigera* damaged 7-10 per cent pods causing 5.4 per cent yield loss and damaged 6.7 per cent pods and 6.2 per cent grains per meter row length. Yield loss of 400 kg/ha by pod borer was resulted after 30-40 per cent average damage of pods during favourable weather conditions and damage reached up to 90-95% (Rahman, 1990; Sachan and Katti, 1994) [7, 8]. *H. armigera* larval population buildup is influenced by various climatic factors like rainfall, temperature, relative humidity and sunshine hours. Studying effect of abiotic factors is prerequisite for integrated pest management, which can therefore be enhanced after determining the seasonal abundance (Mathur *et al*., 2003) [9]. The knowledge on the seasonal incidence of gram pod borer will certainly be helpful in formulating the insect pest management strategies for *H. armigera*. In the present study an attempt was made to study the effect of the abiotic factors on the seasonal abundance of *H. armigera* on chickpea under Varanasi conditions.

Material and methods

A bulk plot of 100 m^2 was raised at Agricultural Research Farm, Institute of Agricultural Sciences, BHU, Varanasi during 2015-16 and 2016-17 to study the population build up of *H. armigera*. A popularly grown variety, RADHEY was selected for this study and standard agronomic practices were followed as per recommendation. The experimental plot was maintained without any insecticidal sprays. Number of *H. armigera* larvae per 10 randomly selected plants was counted in this unprotected plot at 7 days interval (standard week basis) from the occurrence or initiation of pest infestation and was continued up to maturity. Simultaneously weather data i.e rainfall, temperature (maximum and minimum), relative humidity (morning and evening) and sunshine hours were recorded from the metrological observatory available at Agricultural farm. I.Ag.Sc., BHU, Varanasi. These weather parameters were correlated with the occurrence of the *H. armigera* larval population. A Correlation coefficient method was adopted to work out the relationship between the occurrence of the pest and the weather parameters.

Results and Discussion

2015-16

The incidence of *H. armigera* on chickpea crop along with meteorological observations during *Rabi* 2015-16 has been presented in Table-1. The data showed that the larval population of *H. armigera* appeared first during 4^{th} standard week i.e., third week of January with an initial population of 0.62 larvae/10plants and continued till first week of April i.e. 14^{th} standard week. There was gradual rise in *H. armigera* larval population from 2.14 larvae/10 plants during 5^{th} standard week to 4.49 larvae/10 plants on 7^{th} standard week. The larval population attained its peak (9.31 larvae/10 plants) during 9^{th} standard week i.e., last week of February. The corresponding maximum temperature and minimum temperature were 29.9 ^{0}C and 16.2 ^{0}C, respectively while morning RH and evening RH were 85 and 51% and average sunshine hours of 6.4. The larval number declined gradually from 6.53, 5.92, 3.23, 1.01 and 0.89 larvae/10 plants during 10^{th}, 11^{th}, 12^{th}, 13^{th} and 14^{th} standard weeks, respectively. The rainfall was scattered and was not more than 7.7mm only during 3^{rd} standard week.

The correlation coefficient of larval population of *H. armigera* with prevailing weather parameters were worked out and are presented in Table-2. Results showed that during *Rabi* 2015-16, larval population had a non-significant positive correlation with maximum temperature (r = 0.406), minimum temperature (r = 0.445) and evening relative humidity (r = 0.032). Whereas morning relative humidity (r = -0.253) and rainfall (r = -0.164) were observed to have a non-significant negative correlation with larval population. However, sunshine hours had a significantly positive correlation (r = 0.498) with mean larval population.

2016-17

H. armigera incidence on chickpea crop along with meteorological observations during *Rabi* 2016-17 has been presented in Table-3. The data showed that the larval population of *H. armigera* appeared first during 4^{th} standard week i.e. third week of January as 0.53 larvae/10 plants and continued till first week of April i.e. 14^{th} standard week. There was gradual rise in *H.armigera* larval population from 1.27 larvae/10 plants during 5^{th} standard week to 2.76 larvae/10 plants on 7^{th} standard week. The larval population up surged to 6.83 larvae/10plants during 8^{th} standard week and attained its peak (9.87 larvae/10 plants) during 9^{th} standard week i.e., last week of February. The corresponding maximum mean temperature and minimum mean temperature during this standard week were 29.6 ^{0}C and 14.6 ^{0}C while average morning RH and evening RH were 71 and 38%, respectively with mean sunshine hours of 6.8. The average larval number of 7.17 larvae/10 plants during 11^{th} standard week declined gradually to 3.97, 1.26 and 0.97 larvae/10 plants during 12^{th}, 13^{th} and 14^{th} standard weeks, respectively.

Further, correlation studies on mean larval population of *H. armigera* with weather parameters during *Rabi* 2016-17 (Table-4) revealed that average larval population was observed to show a non-significant positive correlation with maximum temperature (r = 0.409) and minimum temperature (r = 0.164). A significantly positive correlation was observed between sun shine hours (r = 0.494) and the mean larval population. Mean larval population had a negative and significant correlation with morning relative humidity (r = -0.504) and evening relative humidity (r = -0.538). Whereas rainfall was observed to show a negative non significant correlation (r = -0.149) with average larval population.

Almost similar results were reported by Ramteke *et al.* (2014) [10] from Allahabad where initial larval population of *H. armigera* was observed during 4^{th} standard week i.e. fourth week of January and the peak population was reported on 10^{th} standard week. Further studies also revealed that the larval population gradually decreased as the summer approaches and the crop is nearer to maturity. In the present study, a peak population of 9.31 and 9.87 larvae per 10 plants was recorded during 2015-16 and 2016-17, respectively when crop is in pod filling stage. Such observations were made in the past by Bajya *et al.*, 2010 [11] who recorded a peak population of 9.2 larvae per 10 plants and experiments of Yadav and Jat (2009) [12] also revealed that peak larval population of *H. armigera* was attained during pod formation stage. Gradual decrease in the larval population after attaining a peak was observed during the both years of experiment which was in concurrence with the findings of Chatar *et al.* (2010) [13].

Earlier reports also suggest that there was a positive association of pest population with maximum temperature and minimum temperature and such studies were comprehensively presented by Kumar and Srivastava (2017) [14], Parmar *et al.* (2015) [15] and Pandey *et al.* (2014) [16] showed that morning and evening relative humidity had negative correlation with larval pest population of *H. armigera* and similar observations were also made by Kumar and Srivastava (2017) [14]. In another study Kumar and Bisht (2013) [17] reported that sunshine hours showed positive association and rainfall depicting negative correlation with the pest population and such results were also ascertained by Shinde *et al.* (2013) [18]. Further, Singh *et al.* (2015) [19] reported that rainfall (mm/week) did not show any consistence role with *H. armigera* population. The present results are in conformity with these studies as well.

Table 1: Influence of abiotic factors on seasonal incidence of *H. armigera* on chickpea during 2015-16.

Week No.	Month & Date	Rainfall (mm)	Temperature ^{0}C		Relative Humidity (%)		Sunshine hours	No. of larvae /10 plants
			Max.	Min.	Morning	Evening		
49	Dec 03-09	0.8	24.6	14.8	93	62	2.2	0
50	Dec 10-16	0	22.7	11.4	92	56	3.7	0
51	Dec 17-23	0	22	8.2	91	43	3.8	0
52	Dec 24-31	0	22.8	8	82	37	5.4	0
1	Jan 01-07	0	24.3	9.6	94	47	2.5	0
2	Jan 08-14	0	25	10.7	85	45	5.9	0
3	Jan 15-21	7.7	19	11	94	69	0.6	0
4	Jan 22-28	0	21.7	7.2	85	43	5.2	0.62
5	Jan 29-04	0	24.7	11.9	79	50	6.5	2.14
6	Feb 05-11	0	24.5	9.6	83	52	6.3	2.76
7	Feb 12-18	2.4	27.1	13.5	85	57	6.3	4.49
8	Feb 19-25	0	28.6	14.9	77	44	8.5	5.44
9	Feb 26-03	0	29.9	16.2	85	51	6.4	9.31
10	Mar 04-10	0	30.9	17.9	77	46	7.6	6.53
11	Mar 11-17	0	28.9	16.6	73	51	6.4	5.92
12	Mar 18-24	0	33.6	17.3	61	26	9.6	3.23
13	Mar 25-31	0	35.5	18.4	58	34	9	1.01
14	April 01-07	0	38.3	23.1	63	26	7.9	0.89

*Natural enemies population includes spiders, coccinellids and predatory bugs

Table 2: Correlation coefficient (r) of *H. armigera* larval population on chickpea with prevailing weather parameters during 2015-16

Insect Pest	Rainfall (mm)	Weather parameters				
		Temperature (^{0}C)		Relative Humidity (%)		Sunshine Hours
		Maximum	Minimum	Morning	Evening	
H. armigera	-0.164	0. 406	0.445	-0.253	0.032	0.498*

** Correlation is significant at the 0.01 level, * Correlation is significant at the 0.05 level

Table 3: Influence of abiotic factors on seasonal incidence of *H. armigera* on chickpea during 2016-17.

Week No.	Month & Date	Rainfall (mm)	Temperature ^{0}C		Relative Humidity (%)		Sunshine hours	No. of larvae /10 plants
			Max.	Min.	Morning	Evening		
49	Dec 03-09	0	20.3	16.3	94	78	2.1	0
50	Dec 10-16	0	20.2	10	94	73	3.5	0
51	Dec 17-23	0	23.3	9.8	89	50	2.8	0
52	Dec 24-31	0	20.5	10.9	94	69	5.7	0
1	Jan 01-07	0	20.1	11.6	95	76	2.3	0
2	Jan 08-14	0	20.7	8.2	91	44	4.8	0
3	Jan 15-21	0	23	8.8	90	49	0.7	0
4	Jan 22-28	1	24.4	10.9	90	58	5.3	0.53
5	Jan 29-04	0	23.8	14.1	94	57	6.6	1.27
6	Feb 05-11	0	25.4	10.8	91	47	6.7	1.98
7	Feb 12-18	0	26.2	12.3	87	53	6.2	2.76
8	Feb 19-25	0	27.7	13	81	41	8.1	6.83
9	Feb 26-03	0	29.7	13.1	83	43	6.1	8.02
10	Mar 04-10	0	29.6	14.6	71	38	6.8	9.87
11	Mar 11-17	0	28.7	12.3	81	39	6.4	7.17
12	Mar 18-24	0	33.2	17.6	81	36	9.2	3.97
13	Mar 25-31	0	38.5	20.1	64	30	8.9	1.26
14	April 01-07	0	38.8	22.4	70	37	7.7	0.97

*Natural enemies population includes spiders, coccinellids and predatory bugs

Table 4: Correlation coefficient (r) of *H. armigera* larval population on chickpea with prevailing weather parameters during 2016-17

Insect Pest	Rainfall (mm)	Weather parameters				
		Temperature (^{0}C)		Relative Humidity (%)		Sunshine Hours
		Maximum	Minimum	Morning	Evening	
H. armigera	-0.149	0.409	0.164	-0.504*	-0.538*	0.494*

** Correlation is significant at the 0.01 level, * Correlation is significant at the 0.05 level

Conclusion

It was observed from the experiment that the *H. armigera* larval population was observed on the chickpea crop during 4th standard week and continued till the maturity of the crop. The peak population was observed when the crop is in the pod formation stage i.e. during 9th to 10th standard week. The correlation studies showed that the *H. armigera* larval population was non significant and negatively correlated with rainfall and morning humidity. Correlation between sunshine hours and larval population was observed to be significantly positive while maximum and minimum temperature was non-significant and negatively correlated with pest population.

The above results show that sunny days coupled with dry spell will aggravate the *H. armigera* population.

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