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Monitoring of gram pod borer, *Helicoverpa armigera* (Hübner) through pheromone traps on long duration pigeonpea [*Cajanus cajan* (L.) Millsp.]

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Abstract
The population of *H. armigera* was monitored using pheromone traps installed in the pigeonpea (cv. Bahar) fields at Varanasi during *Kharif* season of the year 2015-16 and 2016-17. During both the years, the adult male moth activities were first noticed in the 4th standard week and the population attained its peak level in the 12th standard week (7.5 moths/ trap and 10 moths/ trap, respectively). The correlation between pheromone trap catches and larval count for same week were highly significant and positive, r = + 0.952** and r = + 0.904**. Correlation analysis with weather parameters indicated that the emergence of *H. armigera* adults had a significant positive association with maximum temperature, minimum temperature and sunshine hours, while relative humidity exhibited a significant negative correlation with adult moth activity. The regression equation revealed that variations of different weather variables caused approximately 88.8 and 85.6 per cent variations in *H. armigera* trap catches during both years, respectively.

Keywords: Monitoring, *Helicoverpa armigera*, Pheromone trap, Pigeonpea, Weather parameters

1. Introduction
Pulses are second most important dietary component in South Asia after cereals and growing legume pulses enriches soil health because of their nitrogen fixing ability in soil [1]. Pulses in India have long been considered as the poor man's only source of protein [2] and India accounts for about 33 per cent of the world area and 22 per cent of the world production of pulses [3]. Pigeonpea is an important pulse crop grown in semi-arid tropics and sub-tropical areas of the world. India accounts for more than 90 per cent of the world's pigeonpea production and area [4]. Though, India is largest producer of pigeonpea, its productivity has always been a concern. The low productivity of pigeonpea in the country may be attributed to many reasons, among which damage by insect pests is of paramount importance [5].

The gram pod borer, *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) is the most important insect pest of pigeonpea, out of more than 200 species recorded at its various growth stages [6], with an estimated loss of 328 million dollars annually in the semi-arid tropics [7]. Most of the economic damage due to this pest is mainly because of its feeding habit on flowers and pods, thereby causing extensive pod as well as seed damage [8] resulting in direct reduction of the crop yield [9]. High polyphagy, mobility and fecundity are major factors contributing to the serious pest status of *H. armigera* [10]. It has also developed resistance to the widest range of insecticides worldwide, with populations having demonstrated resistance to organochlorines, organophosphates, carbamates, synthetic pyrethroids, spinosad and *Bt* toxins [11, 12]. Hence, various Integrated Pest Management (IPM) practices are now being upgraded periodically for the management of *H. armigera*.

Pheromone technology possesses enormous potential as one of the tools in IPM. Pheromone helps in monitoring insect pest population and also indirectly controls them either by male annihilation through mass trapping or by mating disruption [6]. Adult population of *H. armigera* has been monitored successfully throughout India with the help of pheromone traps [13]. Forecasting of the pest occurrence and peak activity periods is the prerequisite for development of an economically viable, environmentally sound and easily adaptable pest management programme [9].

Hence the present investigation was focused on monitoring the population of *H. armigera* on pigeonpea by use of pheromone traps and also to study the impact of different weather parameters on trap catches.

2. Materials and Methods

For monitoring the population of *H. armigera* on pigeonpea (cv. Bahar) through pheromone traps, field experiments were conducted at Agriculture Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi during *Kharif* 2015-16 and 2016-17. Two pheromone traps (plastic funnel traps having diameter of 11 cm, Plate 1) were installed into the field in the 1st standard week. The rubber septa of these traps were impregnated with 2mg of pheromone blend of Helilure [(Z) 11 – hexadecenal and (Z) 9 – hexadecenal (97: 3)] and the septa were replaced with a new one after every 21 days. The pheromone traps were deployed at the height of 0.5 m above the crop canopy for trapping the maximum number of the male moths. The distance between the traps was maintained at 40 ± 5 m (at this distance there is no attraction interference between two traps). Trapped male moths were counted and averaged for each standard week. Observations on larval population of *H. armigera* were also recorded at weekly interval from ten randomly selected plants to study the relationship between the pheromone trap catches and corresponding field population. Impact of weather parameters on pheromone trap catches was also worked out. For this, the data was subjected to correlation and regression analysis with weather parameters *viz*., maximum and minimum temperature, average relative humidity, rainfall, sunshine hours and wind velocity in respect of the corresponding standard week. The meteorological data for the above analysis were obtained from the meteorological observatory of the university.

2.1 Statistical analysis

Significance of simple correlation was estimated by using *t*-test [14] and the regression equations were derived by using the formula as suggested by Panse and Sukhatme [15].

3. Results and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under the following heads:

3.1 Activity of the adult moths of gram pod borer, *H. armigera*

The population of gram pod borer, *H. armigera* was monitored using pheromone traps installed in the pigeonpea (cv. Bahar) field, starting from 1st standard week (bud initiation stage) to the 15th standard week (pod maturity stage). During 2015-16 the adult male moth activities were first noticed during 4th standard week (1.0 moth/ trap). The population rose gradually up to 12th standard week (7.5 moths/ trap), then after it declined sharply. High moth populations were also recorded during 10th standard week (5.5 moths/ trap) and 11th standard week (6.0 moths/ trap). Minimum population of moths was recorded during 4th standard week (1.0 moth/trap) closely followed by 5th standard week (1.5 moths/ trap). The average moth catches per standard week was worked out to be 2.9 (Fig. 1).

Similar trend of adult moth population of *H. armigera* was also recorded during 2016-17. The peak population of moth catches was noticed in the 12th standard week (10 moths/ trap) followed by 13th standard week (9 moths/ trap) and 11th standard week (8 moths/ trap). Thereafter, a decline in the moth catch per trap was observed and the average moth catches per standard week was worked out to be 3.7 (Fig. 2). The present results are in accordance with the findings of Singh *et al.* [16] who reported that the activity of *H. armigera* moth was present in good number during the entire month of March and the first fortnight of April at Faizabad in Uttar Pradesh, thereby suggesting that the management activities should be taken up during this period only. Similarly, Kumar *et al.* [17] also found that the pheromone traps data showed clear-cut two periods of activity of *H. armigera* moths, first from 14th to 19th standard week in 2011 and second from 6th to 16th standard week during 2012. However, in Andhra Pradesh two peaks were observed during August to September and November to December in groundnut and pigeonpea ecosystem respectively [13].

3.2 Relationship between the pheromone trap catches and corresponding field population

Pest monitoring is only reliable when the relationship between the pheromone trap catches and the corresponding field population estimates are good and consistent across time. Observations made on *H. armigera* larval population during the same period of study showed a maximum larval population (4.7 larvae/ plant and 5.0 larvae/ plant, respectively) in the pigeonpea fields during 12th standard week of both the years, which coincided with the period of peak moth activities. Significant positive correlation (r = 0.952** and r = 0.904**) was obtained between moths trapped and larval population (Table 2). Similar kind of positive correlation was also observed by Prabhakar *et al.* [18] and Srivastava and Srivastava [19] in chickpea.

Dayakar and Rao [20] have also reported that pheromone trap catches are positively correlated with the number of eggs laid and the subsequent larval population in pigeonpea. Similarly, the relationship between pheromone trap catches and egg and larval counts of H. armigera have been worked out on short duration pigeonpea [21]. The correlation between egg count and larval count for same week were highly significant and positive, r = +0.975 and r = +0.994 during *kharif* 2001 and 2002, respectively. Chhabra and Kooner [22] also reported that the peak activity of the noctuid coincided with the pod formation and harvest of the legume crops.

3.3 Influence of weather parameters on trap catches

Simple correlation was worked out between the weather parameters and pheromone trap catches of *H. armigera* in order to study the impact of different abiotic factors on adult emergence of this insect pest. The analytical data on correlation coefficient during both the years (2015-16 and 2016-17) indicated that trap catches of *H. armigera* exhibited a significant positive correlation with maximum temperature (r = 0.692** and 0.639*, respectively), minimum temperature (r = 0.599* and 0.630*, respectively) and sunshine hours (r = 0.699** and 0.691**, respectively) whereas a significant negative relationship was found with average relative humidity (r = – 0.688** and – 0.619*, respectively). The other abiotic factors did not show any significant impact on incidence of the pest (Table 1). Thus, temperature and sunshine hours were the two weather parameters found to be most favourable for adult emergence.

The regression coefficient revealed that the various abiotic factors were found to be most influencing factor, which contributed (R^2 = 0.888 and 0.856) 88.8 and 85.6 per cent variation in *H. armigera* trap catches during both the years, respectively. The regression equation was fitted to study the effectiveness of weather parameters (2015-16) indicated that for every 1ºC increase in maximum temperature, 1ºC increase in minimum temperature, one hour increase in sunshine period and one km/hr increase in wind velocity there would be an increase of 0.268, 0.448, 0.604 and 2.369 numbers of *H. armigera* trap catch, while for every one per cent increase in average relative humidity and 1 mm increase in rainfall there would be a decrease of 0.330 and 0.223 numbers of *H. armigera* trap catch respectively (Table 3).

Similarly during 2016-17, for every 1ºC increase in maximum temperature, 1ºC increase in minimum temperature, one hour increase in sunshine period and one km/hr increase in wind velocity there would be an increase of 0.315, 0.386, 0.904 and 0.525 numbers of *H. armigera* trap catch, while for every one per cent increase in average relative humidity and 1 mm increase in rainfall there would be a decrease of 0.097 and 0.084 numbers of *H. armigera* trap catch respectively (Table 4). Similarly, Bajya *et al.* [23] correlated population fluctuations of *H. armigera* with weather parameters and found that among different weather parameters, temperature had greater role in the incidence on pigeonpea.

Sharma *et al.* [24] who reported that abiotic factors like maximum and minimum temperature had positive correlation while, relative humidity had negative correlation with male moth catches and larval population of *H. armigera* on chickpea further supports the present findings. Rathore *et al.* [25] also reported that the larval population of *H. armigera* on pigeonpea had significant positive correlation with mean temperature and negative non-significant correlation with relative humidity. In contrast, Kumar and Durairaj [6] reported that the emergence of *H. armigera* adults had a significant negative association with minimum temperature while, other parameters (maximum temperature, relative humidity, rainfall and rainy days) had no influence on *H. armigera* activity.

Table 1: Correlation studies between weather parameters and *H. armigera* adult populations during *Kharif* 2015-16 and 2016-17.

Weather Parameters	*H. armigera* populations	
	2015-16	2016-17
Maximum temperature (ºC)	0.692**	0.639*
Minimum temperature (ºC)	0.599*	0.630*
Average relative humidity (%)	- 0.688**	- 0.619*
Rainfall (mm)	- 0.298 ns	- 0.162 ns
Sunshine (hours)	0.699 **	0.691 **
Wind velocity (km/hr)	0.341 ns	0.149 ns

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

Table 2: Correlation coefficient between male moth catches and larval population of *H. armigera* during *Kharif* 2015-16 and 2016-17.

H. armigera	Adult male moth emergence	
	2015-16	2016-17
Larval population	0.952**	0.904**

** Correlation is significant at 0.01 level (Two-tailed)

Table 3: Multiple regression analysis of *H. armigera* adult populations with different weather variables during *Kharif* 2015-16.

Multiple regression	Temperature (º C)		Average Relative humidity (%) (X_3)	Rainfall (mm) (X_4)	Sunshine hours (X_5)	Wind velocity (km/hr) (X_6)
	Maximum (X_1)	Minimum (X_2)				
Coefficient	0.268	0.448	- 0.330	- 0.223	0.604	2.369
Standard Error	0.528	0.521	0.120	0.046	0.474	0.780
T value	0.626	0.414	0.025	0.001	0.238	0.016
F value	10.535					
R^2	0.888					
Regression equation	Y_1 = - 41.965 + 0.268 (X_1) + 0.448 (X_2) – 0.330 (X_3) – 0.223 (X_4) + 0.604 (X_5) + 2.369 (X_6)					

Y_1 = *H. armigera* adult male population (2015-16), **X_1=** Maximum temperature (ºC), **X_2 =** Minimum temperature (ºC), **X_3 =** Average relative humidity (%), **X_4 =** Rainfall (mm), **X_5 =** Sunshine (hours), **X_6 =** Wind velocity (km/hr)

Table 4: Multiple regression analysis of *H. armigera* adult populations with different weather variables during *Kharif* 2016-17.

Multiple regression	Temperature (º C)		Average Relative humidity (%) (X_3)	Rainfall (mm) (X_4)	Sunshine hours (X_5)	Wind velocity (km/hr) (X_6)
	Maximum (X_1)	Minimum (X_2)				
Coefficient	0.315	0.386	- 0.097	- 0.084	0.904	0.525
Standard Error	0.536	0.511	0.123	0.141	0.600	0.837
T value	0.587	0.756	0.684	- 0.614	1.513	0.627
F value	1.965					
R^2	0.856					
Regression equation	Y_2 = 7.227 + 0.315 (X_1) + 0.386 (X_2) – 0.097 (X_3) – 0.084 (X_4) + 0.904 (X_5) + 0.525 (X_6)					

Y_2 = *H. armigera* adult male population (2016-17), **X_1=** Maximum temperature (ºC), **X_2 =** Minimum temperature (ºC), **X_3 =** Average relative humidity (%), **X_4 =** Rainfall (mm), **X_5 =** Sunshine (hours), **X_6 =** Wind velocity (km/hr)

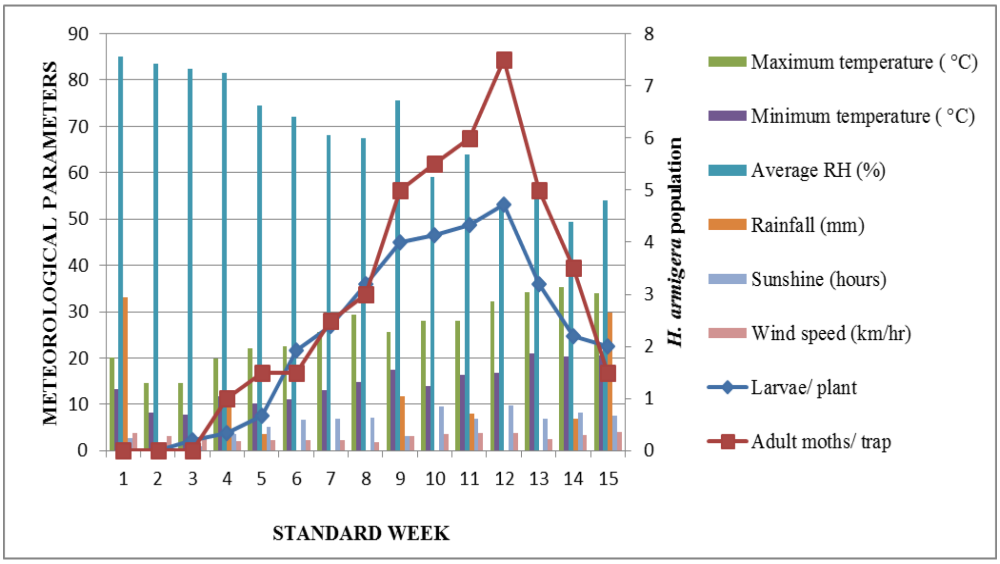

Fig 1: Pheromone trap catches of male moths and larval population of gram pod borer, *H. armigera* on pigeonpea during *Kharif* 2015-16

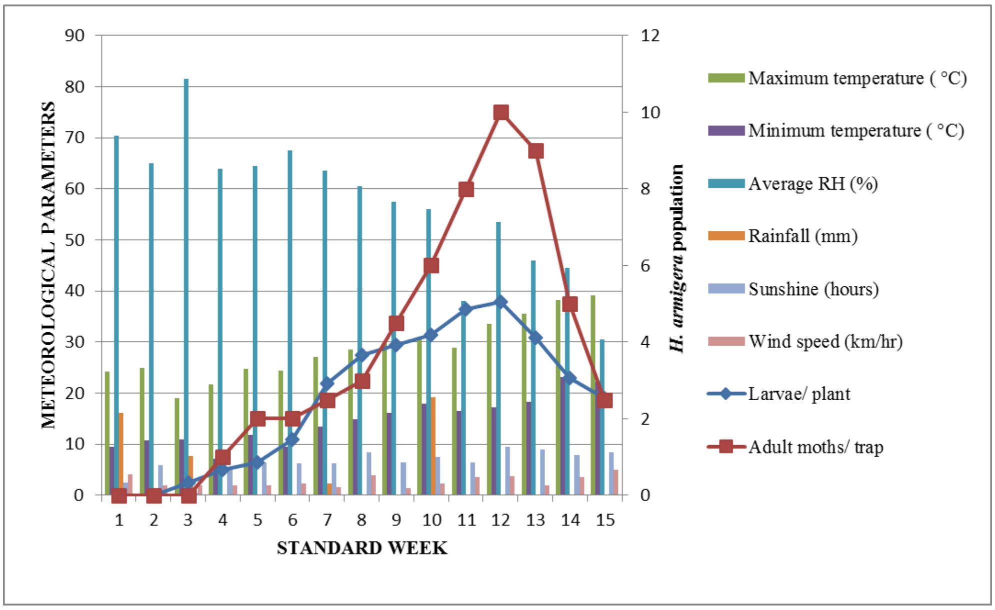

Fig 2: Pheromone trap catches of male moths and larval population of gram pod borer, *H. armigera* on pigeonpea during *Kharif* 2016-17.

Plate 1: Pheromone trap used for monitoring *H. armigera* adults in pigeonpea fields.

4. Conclusion

The present study indicates that the pheromone traps are important tool for monitoring of *H. armigera* population on pigeonpea. The peak emergence of *H. armigera* adults was observed during second fortnight of March that coincided with the period of peak larval activities in the field. Hence the farmers can be alerted during the month of March to take up suitable management practices for effective management of this insect pest on long duration pigeonpea. The activities of adult moths were also found to be greatly influenced by different weather variables mainly temperature, relative humidity and sunshine hours and hence these parameters can be used for development of a region specific prediction model against this pest. Such studies on population build up of insect pests and their relationship with weather parameters provide a clue to improve the IPM strategy against insect pests' infestation and also help in making timely prediction of the occurrence of the pest.

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6. References

1. Nene YL. Indian pulses through the millennia. Asian Agri History. 2006; 10:179-202.
2. Singh AK, Singh SS, Prakash V, Kumar S, Dwivedi SK. Pulses Production in India: Present Status, Bottleneck and Way Forward. Journal of Agrisearch. 2015; 2(2):75-83.
3. Soundararajan RP, Chitra N. Impact of intercrops on insect pests of blackgram, *Vigna mungo* L. Journal of Entomology. 2012; 9:208-219.
4. Mathukia RK, Ponkia HP, Polara AM. In situ conservation and zinc fertilization for rainfed pigeonpea (*Cajanus cajan* L.). The Bioscan. 2016; 11(1):247-250.
5. Khamoriya J, Keval R, Chakravarty S, Mishra VK. Evaluation of sequential application of insecticides against major insect pests on long duration pigeonpea [*Cajanus cajan* (L.) Millsp.]. Journal of Entomology and Zoology Studies. 2017; 5(3):1891-1894.
6. Kumar JR, Durairaj C. Population dynamics of gram pod borer (*Helicoverpa armigera*) in relation to weather factors under Tamil Nadu conditions. Journal of Food Legumes. 2012; 25(1):83-85.
7. Sharma HC, Smith RTJ, Clement SL. Insect pests: Pod borers. In: Chen W, Sharma HC and Muehlbauer FJ (Eds), Compendium of Chickpea and Lentil Diseases and Pests. The American Phytopathological Society, Minnesota (USA), 2011, 121.
8. Muthomi JW, Otieno PE, Chemining'wa GN, Nderitu JH, Wagacha JM. Effect of chemical spray on insect pests and yield quality of food grain legumes. Journal of Entomology. 2008; 5:156-163.
9. Srivastava CP, Joshi N, Trivedi TP. Forecasting of *Helicoverpa armigera* populations and impact of climate change. Indian Journal of Agricultural Sciences. 2010; 80(1):3-10.
10. Gill AK, Arora R, Pathania PC. Morphological characterization of *Helicoverpa armigera* (Hübner) populations from various hosts in Punjab. Agricultural Research Journal. 2015; 52(3):73-78.
11. Deepa M, Srivastava CP. Genetic diversity in *Helicoverpa armigera* (Hübner) from different agroclimatic zones of India using RAPD markers. Journal of Food Legumes. 2011; 24(4):313-316.
12. Jouben N, Agnolet S, Lorenz S, Schone SE, Ellinger R, Schneider B *et al*. Resistance of Australian *Helicoverpa armigera* to fenvalerate is due to the chimeric P450 enzyme CYP337B3. Proceedings of the National Academy of Sciences. 2012; 109(38):15206-15211.
13. Trivedi TP, Yadav CP, Vishwadhar, Srivastava CP, Dhandapani A, Das DK *et al*. Monitoring and Forecasting of *Heliothis*/*Helicoverpa* populations. In: Sharma HC (Ed), *Heliothis/Helicoverpa* Management: Emerging Trends and Strategies for Future Research. Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi, 2005, 119-140.
14. Saxena K, Ujagir R. Effect of temperature and relative humidity on pod borer in pigeonpea. Journal of Food Legumes. 2007; 20:121-123.
15. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. ICAR publications, New Delhi, India, 1985.
16. Singh HM, Ali S, Singh RA, Chakraborti DK, Singh VK, Rajput SKS *et al*. Integrated pest management in pigeonpea. Annals of Plant Protection Sciences. 2003; 11(1):143-183.
17. Kumar MM, Kumar S, Kumar P. Population fluctuation and natural enemies of *Helicoverpa armigera* (Lepidoptera: Noctuidae) on chickpea and their relationship with the environment. Journal of Experimental Zoology, India. 2015; 18(2):759-764.
18. Prabhakar MSP, Singh Y, Singh SP, Singh S. Predicting *Helicoverpa armigera* in chickpea by using sex pheromone traps. Indian Journal of Entomology. 1998; 60:339-344.
19. Srivastava CP, Srivastava RP. Monitoring of *Helicoverpa armigera* (Hubner) in chickpea (*Cicer arietinum* L.). Journal of Applied Entomology. 1995; 119:607-609.
20. Dayakar S, Rao PA. Evaluation of trap height and monitoring of *Helicoverpa armigera* (Hubner) in pigeonpea. Shaspa. 2000; 7(2):152-158.
21. Joshi N, Sivastava CP. Monitoring of *Helicoverpa armigera* (Hubner) by pheromone trapping in short duration pigeonpea, *Cajanus cajan* (L.) Millsp. International Journal of Tropical Agriculture. 2007; 25(4):975-980.
22. Chhabra KS, Kooner BS. Assessment of *Heliothis armigera* (Hubner) population through pheromone traps at Ludhiana, India. Zeitchrift fur Angewandte Zoologie. 1993; 79(3):309-317.
23. Bajya DR, Monga D, Tyagi MP, Meena BL. Population dynamics of *Helicoverpa armigera* on chickpea, pigeonpea and cotton in correlation with weather parameters. Annals of Plant Protection Sciences. 2010; 18(1):227-229.
24. Sharma PK, Kumar U, Vyas S, Sharma S, Shrivastava S. Monitoring of *Helicoverpa armigera* (Hubner) through pheromone traps in chickpea (*Cicer arietinum*) crop and influence of some abiotic factors on insect population. Journal of Environmental Science, Toxicology and Food Technology. 2012; 1(5):44-46.
25. Rathore HK, Vyas AK, Ahir KC, Saini A, Kumar P. Population dynamics of major insect pests and their correlation with weather parameters in pigeonpea (*Cajanus cajan* Millsp.) The Bioscan. 2017; 12(1):01-04.