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Monitoring of Gram Pod Borer, *Helicoverpa armigera* (Hübner) through Pheromone Traps in Different Modules of Short Duration Pigeonpea

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ABSTRACT

Present investigations were carried out during *Kharif* season of 2013-14 and 2014-15 at the Agricultural Research Farm, Banaras Hindu University, Varanasi to monitor the population of *Helicoverpa armigera* (Hubner) by using pheromone traps and to start appropriate control measures in time. The maximum numbers of moth catches were recorded during 44th (16.8 pheromone trap^{-1}) and 45th (19.5 pheromone trap^{-1}) standard week in all the modules during *Kharif* 2013 and 2014. Relationship between pheromone trap catches and egg population was found significant and positively correlated in all modules except M3 during 2013. In the succeeding year 2014, the correlation between pheromone trap catches and egg population was positive and significant only in case of M5. The correlation between pheromone trap catches and larval population was positive in all modules but significant in case of M1 during 2013. In the succeeding year 2014, the correlation between pheromone trap catches and larval population was positive in all modules but significant only in M5.

Key words: Correlation, *H. armigera*, Pheromone trap, Pigeonpea.

INTRODUCTION

Pigeonpea [*Cajanus cajan* (L.) Mill.] is known by more than 350 dialect names, the crop ranks fourth in importance as edible legume in the world. It is the second most important pulse crop after chickpea in India (Das *et al.,* 2015). India imported about 4 million tonnes of pulses during 2012-13, and the production of pigeonpea faced a decrease from 3.07 to 3.04 million tonnes during 2012-13 to 2013-14 with an import pressure of 0.33 million tonnes to meet the demand of 3.30 million tonnes (Anonymous, 2015). Pigeonpea is mainly grown as marginal or a component of mixed cropping system in cotton, sorghum and soybean, receiving less attention of farmers (Sharma *et al*., 2011). Yield of this crop has remained stagnant for the past 3 to 4 decades, largely due to damage inflicted by insect-pests (Basandrai *et al*., 2011). Mandal *et al*. (2009) observed that pigeonpea was infested with as many as 21 insect-pests and two species of mites at different stages of crop growth in an overlapping manner. Balikai and Yelshetty (2008) revealed that a total of 30 insect pests were found feeding on pigeonpea, out of which two pests *viz*., *H. armigera* and *Aceria cajani* Channa. were recorded as major pests on this crop by causing more than 51 per cent damage to the crop, whereas, 11 insects were recorded as moderate pests by inflicting damage between 31 to 50 per cent. Pigeonpea is attacked by insect-pests right from sowing to harvesting and also during the storage. Climate change may lead to shift in production areas of the pigeonpea as well as changes in geographical distribution, incidence and intensity of pests and diseases. Gram pod borer, *H. armigera* has been a major pest in most parts of the country. *Helicoverpa* causes heavy loss up to 60% with an annual loss estimated to be US $ 400 million in pigeonpea (Anonymous, 2015). To minimize the economic loss caused by *Helicoverpa,* proper monitoring is must. Therefore, keeping these views in mind, the present study was conducted.

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MATERIALS AND METHODS

To monitor the adult population of *H. armigera* the field experiments were conducted at the Agricultural Research Farm, Banaras Hindu University, Varanasi during the *Kharif* seasons of 2013-14 and 2014-15. The short duration pigeonpea variety 'UPAS - 120' which is commonly cultivated in this area, was grown in plots of 5 rows of, 4 m length following row to row and plant to plant spacing of 70 and 20 cm, respectively. The crop was grown following the normal agronomic practices in randomized block design with three replications. The various treatments applied in the modules are given below in the Table 1.

Table 1: Details of treatments in modules and their respective dates of application in *Kharif* 2013-14 and 2014-15.

Modules	Treatments	Date of treatments (2013-14)	Date of treatments (2014-15)
Module-1 (M1)	Pheromone traps @ 20 ha^{-1}	10.09.2013	08.09.2014
	Bird perches @ 20 ha^{-1}	22.09.2013	20.09.2014
	HaNPV @ 500 LE ha^{-1}	13.10.2013	11.10.2014
	NSKE @ 5%	28.10.2013	24.10.2014
	HaNPV @ 500 LE ha^{-1}	12.11.2013	06.11.2014
Module-2 (M2)	Pheromone traps @ 20 ha^{-1}	10.09.2013	08.09.2014
	Bird perches @ 20 ha^{-1}	22.09.2013	20.09.2014
	Bacillus thuringiensis subsp. *kurstaki* @ 1.0 kg ha^{-1}	12.10.2013	10.10.2014
	Spinosad 45 SC @ 73 g a.i./ha	27.11.2013	24.10.2014
	Bacillus thuringiensis subsp. *kurstaki* @ 1.0 kg ha^{-1}	12.112013	06.11.2014
Module-3 (M3)	Pheromone traps @ 20 ha^{-1}	10.09.2013	08.09.2014
	Bird perches @ 20 ha^{-1}	22.09.2013	20.09.2014
	HaNPV @ 500 LE ha^{-1}	13.10.2013	10.10.2014
	Indoxacarb 14.5 SC @ 60 g a.i./ha	28.11.2013	24.10.2014
	HaNPV @ 500 LE ha^{-1}	12.11.2013	06.11.2014
Module-4 (M4)	Pheromone traps @ 20 ha^{-1}	10.09.2013	08.09.2014
	Bird perches @ 20 ha^{-1}	22.09.2013	20.09.2014
	Indoxacarb 14.5 SC @ 60 g a.i./ha	12.10.2013	11.10.2014
	Imidacloprid 17.8 SL @ 20 g a.i./ha	27.11.2013	24.11.2014
	Indoxacarb 14.5 SC @ 60 g a.i./ha	12.11.2013	06.11.2014
Farmer's practice (M5)	Pheromone traps @ 20 ha^{-1}	10.09.2013	08.09.2014

Techniques for the experimentation

All the experiments were done under the natural field population of *H. armigera* (Lepidoptera: Noctuidae).

Installation of pheromone traps

One pheromone trap was installed in the first week of September in each module for monitoring the adult population of *H. armigera*. The pheromone septa were impregnated with 2 mg pheromone and were replaced with a new one after every 18 days. The pheromone traps were set up at the height of 0.5 m above the crop canopy for trapping the maximum number of male moths. The months caught in these traps were removed and killed at weekly intervals.

Erection of bird perches

The bird perches were erected by the end of September in each module for the control of *H. armigera* larvae by the birds. The T - shaped bird perches were made with the help of bamboo stick and erected at 1.0 m above the crop canopy so that bird can easily locate and pick up the larvae from the pigeonpea plants.

Preparation of spray materials

The spray mixtures for each treatment in all the modules were prepared by mixing the required quantity of insecticides and biorationals according to required dose of application.

Observations

The following observations were recorded in each module.

Monitoring of adult population of *Helicoverpa armigera*

The adult population was estimated with the help of pheromone traps in each module. The pheromone traps were placed in the field from first week of September onwards. The data obtained from the pheromone trap catches were recorded once in a week. The moths caught in pheromone traps were removed and killed at weekly intervals.

Estimation of egg and larval population

Number of eggs and larvae from 5 randomly selected and tagged plants were counted at weekly intervals, starting from last week of September up to the pod maturity stage.

The correlation coefficient was worked out between pheromone trap catches of *Helicoverpa* male moth of one week preceding and egg and larval populations.

RESULTS AND DISCUSSION

Male moth catches of *Helicoverpa armigera* in pheromone traps during 2013-14 and 2014-15

The pheromone trap catches of *H. armigera* during *Kharif* 2013-14 were recorded from 38th standard week and till 48th standard week, *i.e.*, last week of October in each of the module including farmer's practice (control) (Table 2). The maximum number of moth catches was recorded in 44th standard week in all the modules including farmer's practice. Among all the modules, the highest moth catches (16.8 pheromone $trap^{-1}$) was obtained in module (M1).

The moth catches of *H. armigera* on pheromone traps during *Kharif* 2014-15 were obtained one week later, *i.e.*, from 38th standard week to 48th standard week in all the modules (Table 3). The maximum number of moth catches was recorded in 45th standard week in respective modules as well as in farmer's practice. Among all the modules, the highest moth catches (19.5 pheromone trap^{-1}) was recorded in M1.

The present findings confirm with the observations of (Yogesh and Kumar 2014; Bajia *et al*., 2016) who reported that adult male moth's activities were noticed from 45th SMW and onwards in both the years of study. Peak population of moths (>4 moths/week) were recorded during 9 -11th SW weeks and 6-11th SW in the first and second year, respectively.

Relationship between pheromone trap catches and egg population during 2013-14 and 2014-15

In the year 2013-14, the correlation between pheromone trap catches of week$_{n-1}$ and egg counts for week$_{n=0}$ was significantly positive in case of M1 (r = + 0.594) M3 (r = + 0.565) M4 (r = + 0.649) M4 (r = + 0.844). It was obvious from the Table 4 that the first peak in pheromone trap catches were recorded at 41th standard week, followed by egg peak at 42nd standard week. The second peak in pheromone trap catches was recorded at 43rd standard week, which was followed by the peak of egg count in 44th standard week. In all the modules there was significant positive correlation between the pheromone trap catches and egg population except that of module M3.

In the succeeding year 2014-15, the correlation between pheromone trap catches of week$_{n-1}$ and egg count for week$_{=0}$ was again positive and significant only in case of M5 (r = + 0.831). It was obvious from the Table 5 that the first peak in pheromone trap catches were recorded at 42th standard week followed by egg peak at 43nd standard week. The second peak in pheromone trap catches was recorded at 46th standard week, which was followed by the peak of egg count in 46th standard week. In rest of the modules, the correlation was not significantly different.

The results are in agreement with the findings of Pal *et al.* (2014) who have reported that correlation coefficient between egg counts and pheromone trap catches, were significantly positive. Kadam and Dandale (2003) recorded non-significant correlation between male moth catches of *H. armigera* and infestation in squares, flowers and green bolls of cotton indicating polyphagous nature of the pest. Dayakar and Rao (2000) reported that pheromone trap catches are positively correlated with the number of eggs

Table 2: Male moth catches of *Helicoverpa armigera* in pheromone trap on short duration pigeonpea during *Kharif* 2013-14.

Identifiers			Pheromone catches trap				
Months	Stand. weeks	Dates	M1	M2	M3	M4	M5
September	38	17-23	1.2	1.5	1.0	1.5	1.0
September	39	24-30	2.5	2.0	2.0	1.8	2.2
October	40	01-07	6.8	7.0	7.5	6.5	7.5
October	41	08-14	6.5	6.0	6.5	6.7	7.0
October	42	15-21	12.2	13	12.4	11.8	12
October	43	22-28	6.8	6.5	7.5	6.5	6.0
October	44	29-04	16.8	15.2	16	15.8	16
November	45	05-11	10.5	11.6	12	10.8	11.5
November	46	12-18	5.8	6.2	5.5	6.6	5.2
November	47	19-25	1.0	0.5	1.2	1.0	1.2
November	48	26-02	0.0	0.0	0.0	0.0	0.0

Table 3: Male moth catches of *Helicoverpa armigera* in pheromone trap on short duration pigeonpea during *Kharif* 2014-15.

Identifiers			Pheromone catches trap				
Months	Stand. weeks	Dates	M1	M2	M3	M4	M5
September	38	17-23	0.0	0.0	0.0	0.0	0.0
September	39	24-30	1.2	0.5	0.0	1.5	0.5
October	40	01-07	3.5	3.0	2.5	2.0	3.5
October	41	08-14	9.0	8.5	10	9.5	10.5
October	42	15-21	6.5	7.6	7.5	6.5	5.5
October	43	22-28	13	12.5	11	12.5	11.5
October	44	29-04	9.5	8.5	8.6	7.5	7.0
November	45	05-11	19.5	18	17.2	16.5	15.5
November	46	12-18	7.5	8.0	7.5	7.0	7.2
November	47	19-25	4.5	4.0	3.2	3.5	4.2
November	48	26-02	0.0	0.0	0.0	0.0	0.0

laid and the subsequent larval population in pigeonpea. An increase in moth catches was usually followed by an increase in larval densities.

Relationship between pheromone trap catches and larval population during 2013 and 2014

In the year 2013-14, the correlation between pheromone trap catches of week$_{n-1}$ and larval counts for week$_{n=0}$ was positive in all modules but significant in case of module M1 (r = + 0.594) and M3 (r = + 0.565). It can be seen from the Table 6 that the first peak in pheromone trap catches were recorded at 41th standard week followed by larval peak at 42nd standard week. The second peak in pheromone trap catches was recorded at 43rd standard week, which was followed by the peak of larval count in 44th standard week.

In the succeeding year 2014-15, the correlation between pheromone trap catches of week$_{n-1}$ and larval count for week$_{n=0}$ was again positive and significant only in case of M5 (r = + 0.834). It was obvious from the Table 7 that the first peak in pheromone trap catches were recorded at 42th standard week followed by larval peak at 43nd standard week. The second peak in pheromone trap catches was recorded at 46th standard week, which was followed by the peak of larval count in 46th standard week. In rest of the modules, the correlation was not significantly different.

Dayakar and Rao (2000) also reported that pheromone trap catches are positively correlated with larval population in pigeonpea. Increases in moth catches were usually followed by an increase in larval densities.

Table 4: Correlation between pheromone trap catches of one week preceding and egg population during *Kharif* 2013-14.

Identifiers			Pheromone trap catches of *Helicoverpa* male moth trap^{-1}					Number of *Helicoverpa* egg plant^{-1}				
Months	Std. week	Dates	M1	M2	M3	M4	M5	M1	M2	M3	M4	M5
September	39	24-30	1.2	1.5	1.0	1.5	1.0	0.0	0.0	0.0	0.0	1.0
October	40	1-07	2.5	2.0	2.0	1.8	2.2	1.5	1.38	1.42	1.4	2.2
October	41	08-14	6.8	7.0	7.5	6.5	7.5	1.8	1.4	1.35	1.95	7.5
October	42	15-21	6.5	6.0	6.5	6.7	7.0	2.9	2.7	2.8	2.6	7.0
October	43	22-28	12.2	13	12.4	11.8	12	2.78	2.14	2.36	3.15	12
October	44	29-04	6.8	6.5	7.5	6.5	6.0	3.86	2.52	2.73	3.58	6.0
November	45	05-11	16.8	15.2	16	15.8	16	2.45	1.37	1.76	2.34	16
November	46	12-18	10.5	11.6	12	10.8	11.5	1.89	1.28	1.54	2.02	11.5
November	47	19-25	5.8	6.2	5.5	6.6	5.2	1.36	1.13	1.24	1.89	5.2
November	48	26-02	1.0	0.5	1.2	1.0	1.2	0.5	0.27	0.16	0.38	1.2
Particulars		M1	M2	M3	M4	M5						
Correlation		0.594	0.439	0.565	0.649	0.844						
t. value		2.09 (S)	1.38 (NS)	1.94 (S)	2.41 (S)	4.45 (S)						

NS- Non-significant; S- Significant.

Table 5: Correlation between pheromone trap catches of one week preceding and egg population during *Kharif* 2014-15.

Identifiers			Pheromone trap catches of *Helicoverpa* male moth trap^{-1}					Number of *Helicoverpa* egg plant^{-1}				
Months	Std. week	Dates	M1	M2	M3	M4	M5	M1	M2	M3	M4	M5
September	39	24-30	0.0	0.0	0.0	0.0	0.0	1.4	1.2	1.07	1.35	0.0
October	40	1-07	1.2	0.5	0.0	1.5	0.5	2.76	1.85	2.23	2.17	1.2
October	41	08-14	3.5	3.0	2.5	2.0	3.5	3.04	2.93	3.17	2.76	2.5
October	42	15-21	9.0	8.5	10	9.5	10.5	3.7	3.2	3.75	3.17	2.83
October	43	22-28	6.5	7.6	7.5	6.5	5.5	2.84	2.4	3.02	2.65	4.03
October	44	29-04	13	12.5	11	12.5	11.5	3.92	3.54	4.08	3.8	4.54
November	45	05-11	9.5	8.5	8.6	7.5	7.0	2.4	2.2	2.86	2.17	4.67
November	46	12-18	19.5	18	17.2	16.5	15.5	1.86	1.71	1.62	1.7	3.35
November	47	19-25	7.5	8.0	7.5	7.0	7.2	1.2	1.39	1.34	1.28	2.62
November	48	26-02	4.5	4.0	3.2	3.5	4.2	0.26	0.54	0.45	0.47	0.58
Particulars		M1	M2	M3	M4	M5						
Correlation		0.206	0.303	0.300	0.334	0.831						
t. value		0.60 (NS)	0.90 (NS)	0.89 (NS)	1.00 (NS)	4.01 (S)						

NS- Non-significant; S- Significant.

Table 6: Correlation between pheromone trap catches of one week preceding and larval population during *Kharif* 2013-14.

Identifiers			Pheromone trap catches of *Helicoverpa* male moth trap^{-1}					Number of *Helicoverpa* larvae plant^{-1}				
Months	Std. week	Dates	M1	M2	M3	M4	M5	M1	M2	M3	M4	M5
September	39	24-30	1.2	1.5	1.0	1.5	1.0	0.62	0.58	0.42	0.47	0.73
October	40	1-07	2.5	2.0	2.0	1.8	2.2	1.57	1.45	1.36	1.7	1.68
October	41	08-14	6.8	7.0	7.5	6.5	7.5	1.9	1.9	1.82	1.73	1.86
October	42	15-21	6.5	6.0	6.5	6.7	7.0	2.15	2.23	2.29	2.06	2.01
October	43	22-28	12.2	13	12.4	11.8	12	1.6	1.62	1.45	1.51	1.54
October	44	29-04	6.8	6.5	7.5	6.5	6.0	2.7	2.64	2.66	2.58	2.3
November	45	05-11	16.8	15.2	16	15.8	16	2.12	2.0	2.1	1.98	2.02
November	46	12-18	10.5	11.6	12	10.8	11.5	1.32	1.45	1.5	1.2	1.64
November	47	19-25	5.8	6.2	5.5	6.6	5.2	1.02	1.15	1.14	1.0	1.23
November	48	26-02	1.2	1.5	1.0	1.5	1.2	0.12	0.76	0.45	0.2	0.84
Particulars			M1	M2	M3	M4	M5					
Correlation			0.569	0.476	0.573	0.467	0.523					
t. value			1.96(S)	1.53(NS)	1.98(S)	1.49(NS)	1.73(NS)					

NS- Non-significant; S- Significant.

Table 7: Correlation between pheromone trap catches of one week preceding and larval population during *Kharif* 2014-15.

Identifiers			Pheromone trap catches of *Helicoverpa* male moth trap^{-1}					Number of *Helicoverpa* larvae plant^{-1}				
Months	Std. week	Dates	M1	M2	M3	M4	M5	M1	M2	M3	M4	M5
September	39	24-30	0.0	0.0	0.0	0.0	0.0	0.7	0.42	0.49	0.54	0.6
October	40	1-07	1.2	0.5	0.0	1.5	0.5	1.58	1.76	1.42	1.61	1.73
October	41	08-14	3.5	3.0	2.5	2.0	3.5	1.96	1.86	1.9	1.89	1.8
October	42	15-21	9.0	8.5	10	9.5	10.5	2.2	2.61	2.4	2.1	2.16
October	43	22-28	6.5	7.6	7.5	6.5	5.5	1.7	1.72	1.5	1.61	1.69
October	44	29-04	13	12.5	11	12.5	11.5	2.9	2.73	2.7	2.71	2.62
November	45	05-11	9.5	8.5	8.6	7.5	7.0	2.21	2.14	2.2	2.06	2.1
November	46	12-18	19.5	18	17.2	16.5	15.5	1.14	1.36	1.39	1.0	1.54
November	47	19-25	7.5	8.0	7.5	7.0	7.2	0.84	1.07	1.06	0.89	1.06
November	48	26-02	4.5	4.0	3.2	3.5	4.2	0.1	0.36	0.35	0.25	0.61
Particulars			M1	M2	M3	M4	M5					
Correlation			0.448	0.380	0.464	0.333	0.834					
t. value			1.42(NS)	1.16(NS)	1.48(NS)	1.00(NS)	4.03(S)					

NS- Non-significant; S- Significant.

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 44th (16.8 pheromone trap^{-1}) and 45th (19.5 pheromone trap^{-1}) standard week in all the modules during *Kharif* 2013-14 and 2014-15 *i.e.* last week of October and first week of November, respectively. Hence, the farmers can be alerted during the end of October to take up suitable management practices for effective management of this insect pest on short duration pigeonpea.

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