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Behavioral study of gram pod borer, *Helicoverpa armigera* (Lepidoptera: Noctuidae) and its management in chickpea, *Cicer arietinum*

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ABSTRACT

An experiment on chickpea was conducted to determine the "Behavioral study of gram pod borer, *Helicoverpa armigera* (Lepidoptera:Noctuidae) and its management in chickpea, *Cicer arietinum*" during *rabi* season of 2021-2022 at the Organic research farm Kargunwa ji, Department of Entomology, Institute of Agricultural Sciences, Bundelkhand University, Jhansi (Uttar Pradesh). The population of gram pod borer, *Helicoverpa armigera* was monitored using pheromone trap installed in the chickpea field in variety of RVG-202. During the year the adult male moth activities were recorded in 7th standard week (early pod formation stage) to 12th standard week (pod maturity stage). The number of moth caught per day in the pheromone traps increased steadily during the early morning with a skewed distribution and a peak catch of the moth (49.6%) was observed between 05.00 h and 07.00 h, followed by a gradual decrease to dawn. This was suspended to the roof of the trap, at a height of 1.5 m. above the ground nearer to the crop canopy. Efficacy of different plant protection options *viz*., Neem oil @ 3 ml/lit, *NPV* @ 2 ml/lit, Fixing bird perches @ One perch^{-1}, Lemon grass oil @ 7 ml/lit, Ginger and Garlic extract @ 50 ml/lit and *Annona* leaf extract @ 50 gm/lit were evaluated against the pest. Observations recorded on *Helicoverpa armigera* populations were recorded from five randomly selected plants in each plot before and after 3, 7 and 11 days of spraying. The results revealed that all treatments were significantly superior over control.

Figure : 01 References : 04 Tables : 04
KEY WORDS : Bio-pesticides, Chickpea, Flight pattern, *Helicoverpa armigera,* Sex pheromone

Introduction

The chickpea, *Cicer arietinum*, Family-leguminaceae also known as a Bengal gram, gram garbanzo, bean, ceci bean, sanagalu, chana, has an intresting fact behind its name. It's called chickpea because it looks like baby chick. The pulse is estimated to be at least 7500 year old and was originally cultivated at Mesopotamia and eastern Mediterranean. Chickpea is one of the most important pulses crop. India is the biggest consumer and producer of pulses in the world[4].

India is the largest producer of gram in world followed by Australia, Myanmar. In India, Bengal gram takes first position in total pulses production followed by black gram. Andhra Pradesh produces 5.66 lakh tonnes in an area 4.56 lakh ha With 1218 kg/ha Productivity in 2020-2021. (Third advance estimates, 2020-21, DES-AP). It is grown in about 36 lakh hac.

The chickpea production in India has gone up from 38.55 to 112.29 lakh tonnes during 2000-01 to 2017-18, while the area has also gone up from 51.85 to 105.61 lakh hac. whereas, the yield has steadily increased from 744 kg/hac to 1063 kg/hac. Mostly growing States are Madhya Pradesh, Maharashtra, Orissa, Andhra Pradesh, Gujarat, Rajasthan and Bihar. Chickpea is also cultivated in the neighboring countries viz., Pakistan, Shrilanka, Burma, China, Fiji, and Afghanistan.

It is very important component of cropping system for dry, rain fed areas, because it can prove annually 80 to 120 kg./ha.Nitrogen by symbiotic process. The crop raised is mostly in marginal land which is both thirsty and hungry[3].

Chickpea is rich source of Calcium, Iron, vitamin B & C and niacin and excellent source of high protein (21%), carbohydrate (61-63%) and fat (4-5%) having digestibility. The sour taste of leaves and pods is due to the presence of Mallic acid 90-96% and Oxalic acid 4-

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TABLE-1: The number of occasions when catches of *H. armigera* were recorded in the pheromone trap

	Insect population			Meteorological data				
Days	Trap 1	Trap 2	Trap 3	Temperature (°C)		Relative Humidity (%)		Wind velocity
				Maximum	Minimum	Maximum	Minimum	Mps
12/2/2022	0	0	0	30	12	27	25	2—3
13/2/2022	3	5	2	30	12	23	21	3—4
14/2/2022	2	3	1	31	15	31	29	3—4
15/2/2022	4	1	5	32	13	28	26	4—5
16/2/2022	3	0	3	31	15	29	27	3—4
17/2/2022	2	6	4	30	14	27	25	3—4
18/2/2022	2	5	1	30	14	23	21	3—4
19/2/2022	2	4	1	29	14	19	17	5—6
20/2/2022	1	4	5	30	12	17	15	8—9
21/2/2022	0	3	2	32	12	16	14	3—4
22/2/2022	4	3	1	33	12	16	14	4—5
23/2/2022	5	2	0	33	12	21	19	4—5
24/2/2022	7	5	4	35	14	26	24	4—5
25/2/2022	3	3	8	34	15	26	24	3—4
26/2/2022	6	2	5	35	15	18	16	4—5
27/2/2022	2	1	0	35	15	30	28	4—5
28/2/2022	3	0	0	35	17	29	27	3—4
01/3/2022	1	2	2	35	16	17	15	2—3
02/3/2022	0	4	3	35	19	18	16	3—4
03/3/2022	3	1	0	34	13	17	15	3—4

04/3/2022	4	2	1	37	15	18	16	5—6
05/3/2022	3	1	3	34	15	20	18	5—6
06/3/2022	2	4	3	36	15	18	16	2—3
07/3/2022	2	0	2	36	17	18	16	3—4
08/3/2022	3	0	1	37	17	21	19	3—4
09/3/2022	1	3	0	37	18	18	16	2—3
10/3/2022	2	6	1	37	17	21	19	3—4
11/3/2022	3	2	0	36	20	20	18	5—6
12/3/2022	2	2	2	26	17	13	11	5—6
13/3/2022	5	2	6	32	15	12	10	3—4
14/3/2022	1	0	2	35	17	14	12	6—7
15/3/2022	2	3	1	39	19	16	14	6—7
16/3/2022	0	1	3	35	21	10	8	8—9
17/3/2022	0	1	0	36	21	15	13	5—6
18/3/2022	3	2	2	36	22	18	16	2—3
19/3/2022	3	0	1	35	19	13	11	3—4
20/3/2022	4	3	5	35	16	8	6	5—6
21/3/2022	1	3	3	36	18	9	7	6—7
22/3/2022	7	2	2	37	21	8	6	4—5
23/3/2022	4	3	2	37	19	7	5	5—6

10%. India ranks first among the chickpea growing nations in terms of production and cultivation area[2]. A single larva can consume 30-40 pods in its life time. Yields losses grain due to gram pod borer in chickpea may range from 70-80%.Reported one larvae^{-1} row length as the economic threshold level of *Helicoverpa armigera* in chickpea[1].

Materials and Methods

An investigation on "Behavioral study of gram pod borer, *Helicoverpa armigera* and its management in chickpea, *Cicer arietinum*" during *rabi* season of 2021-2022 at the Organic research farm Kargunwa ji, Department of Entomology, Institute of Agricultural Sciences, Bundelkhand University, Jhansi (UP) was done. Experiment was laid out in Randomized Block Design. The total number of replications were three and total number of treatments seven. Three pheromone traps were installed into the field. The rubber septa of these traps

TABLE-2 : Efficacy of different treatments against gram pod borer, *Helicoverpa armigera* 1st Spray No. of Larvae/plant

Efficacy of different treatments against gram pod borer, *Helicoverpa armigera* 1st Spray No. of Larvae/ plant.

Treatments	DBS	3 DAS	7 DAS	11 DAS	Pool Data
T_0 - Untreated Control	5.38(2.32)	6.42(2.53)	6.75(2.60)	8.71(2.95)	7.29(2.70)
T_1 - Neem oil	4.67(2.16)	3.30(1.82)	3.25(1.80)	2.94(1.72)	3.16(1.78)
T_2 - *NPV*	4.60(2.14)	4.33(2.08)	4.15(2.04)	3.40(1.84)	3.96(1.99)
T_3 - Fixing Bird purches	4.87(2.21)	4.79(2.19)	4.90(2.21)	4.18(2.04)	4.62(2.15)
T_4 - Lemon grass oil	4.40(2.10)	3.23(1.80)	5.70(2.39)	6.23(2.50)	5.05(2.25)
T_5 - Ginger + Garlic Extract	4.40(2.10)	3.56(1.89)	4.36(2.09)	5.47(2.34)	4.46(2.11)
T_6 - Annona leaf Extract	4.80(2.19)	4.47(2.11)	4.68(2.16)	3.87(1.97)	4.34(2.08)
C.D.	N/A	1.09	1.54	2.20	1.61
SE(m)	0.31	0.35	0.51	0.71	0.52

Figures in parenthesis $\sqrt{x}$ + 0.5 transformed values

- $\sqrt{x}$ + 0.5 transformed values are used for analysis
- DBS (Day before spray) DAS (Day after spray)

were synthetic pheromone, a mixture of (Z)-11-hexadecenal and (Z)-9-hexadecenal in the ratio of 97:3 and septa were replaced in every 15 days. This was suspended to the roof of the trap, at a height of 1.5 m. above the ground nearer to the crop canopy. The distance between two traps 10 meter. Pheromone traps had maximum number of male moth caught during standard weeks.

The field trial was laid out at the organic farm field in RBD with 7 treatments including in untreated control, each with 3 replications. The net plot size was 2 x 2.10 m^2 and spacing between R X P was maintained at 30 x 10 cm, respectively. Spray of T_0 = Untreated control, T_1 = Neem oil spray (3 ml/lit), T_2 = *NPV* application (250 LE hac^{-1}), T_3 = Fixing bird perches (One per $plot^{-1}$), T_4 = Lemon grass spray (7 ml/lit), T_5 = Ginger + garlic extract (50 ml/lit), T_6 = *Annona* leaf extract (50 gm/lit). Observations were recorded in randomly on five tagged plants selected from the plots. Observations were recorded on number of larvae per plant.

Results and Discussion

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

Gram pod borer, *Helicoverpa armigera* male activity, influence of weather on the pheromone trap catches, peak moth activity and flight pattern towards the pheromone source:

The pheromone trap catches showed no distinct peak, but fluctuated every day, with the higher catch occurring on different days in the three traps. It could simply reflect difference in the number of *Helicoverpa armigera* present in the nearby crops. A total of 288 males were caught in the three different pheromone traps observed during the study period. The population of

Fig.1 : Pheromone trap used for monitoring *H. armigera* adult in chickpea fields

Helicoverpa armigera was monitored using pheromone traps installed in the chickpea field, 7th standard week (early pod formation stage) to 12th standard week (pod maturity stage). The pheromone trap catches recorded here suggest that *Helicoverpa armigera* males were most active. The environmental factors *viz.,* temperature, relative Humidity, wind velocity affect the male moth catch in pheromone traps. Temperature can affect the rate of pheromone emission from the septa, so that the higher the temperature, the higher the rate of pheromone emission. The number of male moth decrease during the day, because the temperature is high during the day, due to which they are less attracted to the pheromone trap.

The catch increased as the relative humidity increased at the night time. The high wind velocities that tended during maximum male moth catches, with a catch when wind velocities exceeded 8-9 mps. The mean temperature during the study period ranged from 12.01 to 29.92 ^{0}C while the mean humidity during the study period ranged from 43.42 to 83.28 %, the mean wind velocities were ranging nearly 4.31 Kmph.

Flight pattern and orientation towards a sex pheromone source:

Flight behaviour of male gram pod borer, *Helicoverpa armigera* towards the pheromone source was observed from a position of about 10 m to the side of expected flight path and from up wind of the source looking along the path. Male moths showed a consistent stages of flight pattern, and in favorable condition, distinct successive stages of flight were found, performed by almost 90% of about moths identified as *Helicoverpa armigera* on the strict criterion of their halting progress on the pheromone septum or in the air close to it (some insects of about the size of *Helicoverpa armigera* flew straight-wind past the capsule without any apparent recognition of it). In steady wind (during early morning, was around 05.00 h), the moths were first seen in straight and level flight, making rapid progress directly upwind at an altitude of between 1 to 2 m. This portion of the flight was in view of the moon light. At a distance from the source usually within the range of 2 to 4 m. and apparently for a given fixed wind velocity (3-4 Mps), the moths abruptly for a given speed and "speed of flight" performed slower, more undulating flight. The studies conducted on the flight pattern and orientation of male *Helicoverpa armigera* towards the sex pheromone source have shown that, moths fly upwind in a series of horizontal zig-zags motion which decrease in aptitude as the source is approached.

Efficacy of different plant protection options against gram pod borer, *Helicoverpa armigera*

Observation of first spray:

The efficacy of different treatments of all three

TABLE-3 : Efficacy of different treatments against gram pod borer, *Helicoverpa armigera* 2nd Spray No. of Larvae/plant

Efficacy of different treatments against gram pod borer, *Helicoverpa armigera* 2nd Spray No. of Larvae/ plant

Treatments	DBS	3 DAS	7 DAS	11 DAS	Pool Data
T_0 - Untreated Control	8.71(2.95)	9.51(3.08)	11.85(3.44)	12.34(3.51)	11.23(3.35)
T_1 - Neem oil	2.94(1.72)	3.61(1.90)	3.60(1.90)	3.29(1.81)	3.50(1.87)
T_2 – *NPV*	3.40(1.84)	3.39(1.84)	2.00(1.41)	2.17(1.47)	2.52(1.59)
T_3 - Fixing Bird purches	4.18(2.04)	4.27(2.07)	3.84(1.96)	3.87(1.97)	3.99(2.00)
T_4 - Lemon grass oil	6.23(2.50)	5.59(2.36)	5.30(2.30)	4.63(2.15)	5.17(2.27)
T_5 -Ginger + Garlic Extract	5.47(2.34)	4.90(2.21)	4.06(2.01)	3.93(1.98)	4.30(2.07)
T_6 - Annona leaf Extract	3.87(1.97)	3.95(1.99)	3.88(1.97)	4.68(2.16)	4.17(2.04)
C.D.	2.20	1.35	1.65	1.41	1.40
SE(m)	0.71	0.43	0.53	0.45	0.45

Figures in parenthesis $\sqrt{x}$ + 0.5 transformed values

- $\sqrt{x}$ + 0.5 transformed values are used for analysis
- DBS (Day before spray) DAS (Day after spray)

observations of 1st spray indicated that all the different plant protection options were significantly effective in reducing the larval population of gram pod borer, *Helicoverpa armigera* (Hubner) as compared to untreated plots (7.29 larvae/plant). Neem oil (3.16 larvae/plant) was found to be most effective in reducing the larval population of gram pod borer, *Helicoverpa armigera*. It was followed by *NPV* (3.96 larvae/plant), *Annona* leaf extract (4.34 larvae/plant), Ginger + Garlic extract (4.46 larvae/plant), Fixing bird perches (4.62 larvae/plant) and Lemon grass oil (5.05 larvae/plant). Among all different treatments the efficacy of Lemon grass oil and Ginger + Garlic extract were found least effective in reducing the larval populations of gram pod borer, *Helicoverpa armigera*.

Observation of second spray:

The pooled data *Helicoverpa armigera* at pre-treatment and post-treatments observations reveal the treated with *NPV* (2.52 larvae/plant) insecticides had maximum reducing the larval population of *Helicoverpa armigera*. It was followed by treatments of Neem oil (3.50 larvae/plant), fixing bird perches (3.99 larvae/plant), *Annona* leaf extract (4.17 larvae/plant), Ginger + Garlic (4.30 larvae/plant) and Lemon grass oil (5.17 larvae/plant). Lemon grass oil (5.17 larvae/plant) was found least effective in reducing the larval population of *Helicoverpa armigera*.

Observation of third spray:

The pooled data of *Helicoverpa armigera* pre-treatment and post treatment observations reveal the treated with *NPV* (2.56 larvae/plant) has maximum efficacy in reducing the larval population of *Helicoverpa armigera*. It was followed by treatments of Neem oil (3.60 larvae/plant), Fixing bird perches (4.14 larvae/plant), Ginger + Garlic extract (4.39 larvae/plant), *Annona* leaf extract (4.49 larvae/plant) and Lemon grass oil (5.26 larvae/plant). The *Annona* leaf extract and Lemon grass oil were found least effective in reducing the larval population of *Helicoverpa armigera*.

TABLE-4 : Efficacy of different treatments against gram pod borer, *Helicoverpa armigera* 3rd Spray No. of Larvae/plant

Efficacy of different treatments against gram pod borer, *Helicoverpa armigera* 3rd Spray. No. of Larvae/plant.

Treatments	DBS	3 DAS	7 DAS	11 DAS	Pool Data
T_0 - Untreated Control	12.34(3.51)	10.29(3.21)	11.79(3.43)	13.57(3.68)	12.00(3.46)
T_1 - Neem oil	3.29(1.81)	3.91(1.98)	3.59(1.89)	3.62(1.90)	3.60(1.90)
T_2 – *NPV*	2.17(1.47)	3.68(1.92)	1.98(1.41)	2.39(1.55)	2.56(1.60)
T_3 - Fixing Bird purches	3.87(1.97)	4.63(2.15)	3.80(1.95)	4.25(2.06)	4.14(2.03)
T_4 - Lemon grass oil	4.63(2.15)	6.07(2.46)	5.27(2.30)	5.09(2.26)	5.26(2.29)
T_5 -Ginger + Garlic Extract	3.93(1.98)	5.26(2.29)	4.05(2.01)	4.32(2.08)	4.39(2.10)
T_6 - Annona leaf Extract	4.68(2.16)	4.29(2.07)	3.85(1.96)	5.15(2.27)	4.49(2.12)
C.D.	1.45	1.44	1.70	1.55	1.48
SE(m)	0.45	0.46	0.55	0.50	0.48

Figures in parenthesis $\sqrt{x}$ + 0.5 transformed value.

- $\sqrt{x}$ + 0.5 transformed values are used for analysis
- DBS (Day before spray) DAS (Day after spray)

Conclusion

The pheromone trap catches recorded here suggest that gram pod borer, *Helicoverpa armigera* male moth was most active b/w 05.00 and 07.00 hr. The environmental factors *viz.,* temperature, relative Humidity, wind velocity are effective on the male moth catch in pheromone traps. The application of different plant protection options are used for the control of gram pod borer, *Helicoverpa armigera* (Hubner) in chickpea crop. The better performance of *NPV* was found significantly effective of gram pod borer control.

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