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Impact of light traps on population density of gram pod borer, *Helicoverpa armigera* (Hub) (Lepidoptera: Noctuidae) and its larval parasitoid (*Campoletis chlorideae* Uchida) in Rod Kohi area of Dera Ismail Khan, Pakistan

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Abstract

One (T1) and Two (T2) light traps ha^{-1} were compared with control (trap (s) with no light-T3) against gram pod borer, *Helicoverpa armigera* (Hub.) and emergence rate of its larval parasitoid (*Campolitus chlorideae*) were investigated at Rod Kohi, D.I. Khan, Pakistan. T1 resulted in 7.57 mean number of *H. armigera* moths out of 49 total moth catch with average population of 0.306 larva per plant with 5.46% pod damage and average yield of 1980 kg ha^{-1}. In T2, out of 45.26 total moth catch, 5.61 were *H. armigera*, with lowest number of larval population (0.254/plant), lesser pod damage (4.02%) and higher yield (2120 kg ha^{-1}), while in control plots (T3), larval population density was maximum with 0.379 larvae/plant with pod damage of 10.40% and 1834 kg ha^{-1} yield was recorded. Mean number of 5.82 larval parasitoid were trapped in T1 while in T2 there were 5.19 adult parasitoids/trap. Maximum percent (9.047) emergence of larval parasitoids of *H. armigera* was recorded from larvae reared from T3 followed by T1 (7.016) while T2 reared larvae resulted in a minimum emergence of 7.0%. Highest larval mortality was recorded in T1 (9.58) followed by T2 (10.11) and T3 (10.86).

Keywords: Gram, *Helicoverpa,* Light trap, Larval parasitoid, Management

1. Introduction

Gram pod borer, *Helicoverpa armigera*, is considered as a notorious pest of chickpea. It also attacks pigeon pea, mung bean, lentil, soybean okra, maize, berseem, sunflower, sorghum, tobacco and tomato. Besides gram pod borer, it is also known as cotton bollworm, gram caterpillar, tomato fruit worm and tobacco bud worm [1]. Pod borer is the most serious insect pest of Chickpea. Percent larval survival and pupation were the maximum on chickpea as compared to other host plants [2]. Ahmad and Iqbal (1990) [3] recorded 26.2, 41.4 and 42% damage to chickpea due to *H. armigera* in Jacobabad, Dokri and Shikarpur districts of Sind, Pakistan, respectively.

On chickpea, the pest appears in late February and reaches its peak by the end of April. In May the population decreases gradually and rarely found in June [4]. Since not much resistance is available in gram genotype against the pest [5], therefore, farmers are increasingly relying on synthetic insecticides to manage this pest on different crops [6, 7]. Besides causing resistance in pest, pesticides are expensive, have adverse effects on the natural enemies, pollute the environment and cause health hazards [8]. Gram is traditional crop of the inhabitant of the selected area and the study location is one of the most water deficit areas of the province where even drinking water is not easily available. Keeping in view the various constrain, trials were conducted to investigate the efficacy of light traps as a tool for managing the pest population.

2. Materials and Methods

Studies were carried out to check the impact of light traps on the population densities of *H. armigera* and emergence rate of its larval parasitoid (*Campoletis chlorideae*) in Rod Kohi area of D.I. Khan from November 2009 to March 2010. A local variety of chickpea, Karak-1 was used in the experiment in a completely randomized Design. The crop was sown in October

2009 in four different villages at Rod Kohi (two in Draban and two in Chodwan Zam); each village was considered as replicate. In each village there were three treatments including a check. In treatment one (T1) efficacy of single light trap ha^{-1} was tested where as in the second treatment (T2) two light traps per hectare were installed. Untreated plot (T3) in each of the same village was taken as control where traps with no light were installed. Each treatment in the village was about one kilometer distance from the other. Traditional agronomic practices were followed for crop maintenance without any chemical treatment. Light traps were installed in the last week of November 2008 and fortnightly data were recorded till March 2009 on the number of all types of moths $trap^{-1}$, the number of pod borer (*Helicoverpa*) adults caught, the number of larval parasitoid (*C. chlorideae*)/trap.

Data regarding the larval population were recorded fortnightly from mid-December to first week of March. For this purpose, 50 plants were randomly selected from each treatment and the number of *Helicoverpa* larvae per plant was calculated. For percent parasitism of *Helicoverpa* larvae, eight data were collected fortnightly from 29th November till 8th March. For each data 100 larvae were collected at random from each treatment and were brought to the laboratory for rearing & emergence of larval parasitoids. To avoid cannibalism, each larva of respective treatment was kept in separate glass jar with cotton mesh and covering secured with rubber band. Larvae were fed with host leaves by regularly changing the food until the larva changed into mummy or pupa. Each mummified larva/pupa was confined in similar manner covering and regularly observed for the emergence of larval parasitoid. The emerged adult parasitoids were identified and confirmed through CABI Bioscience, Islamabad. Voucher specimens were deposited with the Entomological museum at the Entomology Department, Khyber Pakhtunkhwa Agricultural University, Peshawar, Pakistan.

The percent larval mortality of the lab reared larvae was also calculated for each treatment. In this regard larvae lost due to parasitism were excluded from the total mortality. Data regarding pod damage was calculated by harvesting one m² from the five zones (10, 20, 30, 40, and 50m distance) from the light source of each treatment. Total number of pods and damaged pods were counted and percentage for damaged pods was calculated. In a similar fashion yield in kg/hectare was calculated by harvesting one m² area from the five zones within the treatments and converted into yield (kg/ha) by the following Formula:

$$\text{Yield (kg/ha)} = \frac{weight\ of\ grains\,(gm)\ per\ m^2}{1000\,gm} \times 10{,}000$$

MSTATC, Computer package was used for statistical analysis and means were compared using LSD test. Using Microsoft Excel Starter 2010, Standard deviation (± SD) were calculated where means were not significant.

3. Results

The study revealed that the moths catch was not significantly different with mean number of 49 and 45.26 between treatments T1 and T2 respectively. Seasonal mean of the two treatments varied and fluctuated from 12.56 on 28th December to a high catch of 115.56 on 8th March (Table-1). Similarly the mean number of *Helicoverpa* adults among the all moths was not significantly different in the T1 (7.57) and T2 (5.60). The seasonal mean of the pod borer was 1.42 on 14th December and dropped to 0.00 on 11th January. From the end of January, population started to build with 2.00 pod borers on 25th January to 18.00 pod borers on both 22nd February and 8th March (Table-2). The number of adults of *C. chlorideae* caught in the light traps was not significant either in the two treatments. The mean number of the *C. chlorideae* was 5.82 and 5.19 in the T1 and T2 respectively. The seasonal mean of the parasitoid catch was 1.33 on 14th December. The number of parasitoid catch declined to its low point of 0.19 on 11th January. The population started to build up with 1.69 parasitoid adults caught in the traps on 25th January and reached to its peak of 18.44 on 8th March (Table-3). With the exception of few spiders, no moth and Parasitoid were caught in the control treatment (T3), so T3 is not mentioned in the Table 1, 2 and 3.

The study of larval infestation of the pod borer/plant revealed that T2 resulted significantly lower larval infestation with 0.254 larvae/plant, followed by T1 and T3 with 0.306 and 0.379 larvae per plant respectively (Table-4). The seasonal mean of the larval infestation/plant followed the same pattern as explained for Table 1, 2 and 3. Larval infestation/plant was 0.487 on 14th December and declined to 0.063 on 11th January. It started rebuilding from 25th January with0.194 larvae per plant and reached to its peak of 0.738 on 8th March.

Mean pod borer damage followed the same patron as that of the larval infestation. Mean pod damage was significantly low in T2 with 4.02% pod damage followed by T1 with 5.46% mean pod damage. In T3 with no light trap, the pod damage was 10.40%. The samples collected from the five zones (10 to 50 meters from the light traps) revealed that as the distance from the light source increases the number of pod damage also increases (Table-5). The pod damage was non-significant to each other at 10 (5.39%) and 20 meter (5.94%) zone from the light trap but significantly lower than the 30, 40 and 50 meter with 6.58, 7.26 and 7.97% pod damage respectively. Significantly higher yield of 2120 kg $ha^{-1}$was recorded in T2 followed by T1 with 1980 kg/ha. T3 with no light trap resulted in significantly lower yield of 1834 kg ha^{-1} (Table-6). The yield obtained from 10m, 20, and 30m zones was not significantly different from each other but significantly higher from that of 40 and 50m.

Studies on the percent parasitism of the larvae collected from the three treatments (Table-7) revealed that 7.00 and 7.01% larvae were found parasitized by the larval parasitoid (*C. chlorideae*) in T1 and T2 respectively. Significantly higher number of 9.05% larval parasitism was recorded from T3 (control plots). Data regarding larval parasitism from larvae collected on the various dates revealed that it was 10.96% on 29th November and declined to 8.33, 3.792 and 2.833 on 14th, 28th December and 11th January respectively. The percent parasitism from this point onward increased and peaked to 15.96% on 8th March. Percent larval mortality in the Laboratory reared larvae, collected on the various dates is given in Table-8. It was 80.09, 82.97 and 84.27% in T3, T2 and T1 respectively.

4. Discussion

The studies revealed effectiveness of the light traps against the gram pod borer (*Helicoverpa armigera*). Our results are somewhat in concurrence with Dillon and MacKinnon [9] who reported that once the light trap array was operational the average total egg density dropped to 1.09 eggs per meter in the treatment as compared with 1.3 eggs per meter in the control and concluded that the higher the intensity of light trap the lesser will be the population density. The seasonal mean was zero (0.00) in the first week of January and started to build up at the end of the month. It shows that the pod borer goes into some sorts of hibernation during extreme cold. If we look into the data (table 1 & 2) the pod borer moths is only 15.45% in T1 and 12. 39% in T2 of all the moths caught. It shows that a greater number of other moths are also attracted to the light traps. Ayberk *et al.* [10] used light traps and collected 70 moth species belonging to 15 different families dominated by Noctuidae with 26 specimens.

The study of percent pod damage revealed that the far the area from the light source, the less was the light intensity and the greater was the pod damage. Furthermore Pod damage was less in T2 (4.02%) as compared to T1 (5.46%) and T3 (10.40%). If compared with the control (T3) these figures show about 50 to 60% reduction in pod damage. These studies clearly indicate that by removing adult moths through the light traps, pod damage could be minimized. Data regarding yield from the five zones from the light trap revealed that the far the area from the light source, the lesser was the intensity of light and do so the yield. The yield data revealed 2120 Kg ha^{-1} in T2, 1980 Kg ha^{-1} in T1 and 1834 Kg ha^{-1} in T3. It showed that installation of two light traps per hectare can save about 15% of the potential yield that otherwise would be lost to the pod borer infestation. Dillon and MacKinnon [9] reported negative relationship between light traps and eggs densities of *Helicoverpa* from the cotton fields.

Light traps were run from dawn to dusk each night from November through March. *H. armigera* moths were the dominant species of all the moths capture by the light traps. The estimated number of *Helicoverpa* moths captured each night varied throughout the study period. There are a number of possible reasons for this: The regional abundance of adult moths changes across time; windy conditions reduce moth's flight and the effective radius of light traps varies substantially with the intensity of moonlight. According to Dillon and MacKinnon [9], *H. armigera* and *H. punctigera* moths were the dominant species of insect captured by the Vortex light traps during the study period. Mean catch rate ranged from 18 to 246 *Helicoverpa* moths per trap per night.

The traps captured a number of other insects including the hymenopterans parasitoid (*Compoletis chlorideae*). From mid-December its catches started to decline and were lowest on January 11th. At the end of January its catch increased and reached to a maximum of 18.44 per trap/week on 8th March. This fluctuation could be attributed to the fluctuating temperature and population of the host. We have to keep in mind the other dimension of these findings that during the study period a total of 40.72 and 36.33 adults were caught in the traps. If we take 1:1 of the male and female, 20.36 potential female were removed from the parasitoid population per trap per hectare. Despite this fact, the light trap installation resulted in reduction of the pest population and put a positive impact on the overall yield.

Study about the percent larval parasitism in the reared larvae of *H. armigera* was started at the first egg hatching stage in the laboratory. *C. chlorideae* was the most common larval parasitoid emerged from most of the reared larvae. Most of the parasitoids emerged from 1st, 2nd 3rd instars larvae (data not given). Maximum parasitism was recorded at the first week of March. During our study the highest larval parasitism of 9.047% was recorded in the control plots which is quite low as compared to 25% larval parasitism of *H. armigera* by *C. chloridaea* reported by Garge [12] from Uttar Pradesh, India. Low level of larval parasitism can be attributed to the fact that there are differences in the ecology and timing of the two studies.

The results showed that throughout the study period the traps captured natural enemies in the treated plots that's why lesser parasitism was recorded in treated plots as compared to non-treated ones. At the first week of March pest population reached to its peak so the parasitoid population was also high at this stage.

The larval parasitoid, previously known as *Diadegma* spp, is one of the most common larval parasites of *H. armigera* (Hub.) in India (Bilapate *et al*; Yadav *et al.*) [13, 14]. It is tiny wasp, and considered as egg as well as larval parasitoid of several lepidopteran host including *H. armigera* (Fatma and Pathak) [15]. According to Prasad *et al.* [13], the larval population of *H. armigera* (Hueb.) on the chickpea sown on October 12th was fairly low during the month of December. The highest peak of the pest was recorded in the first week of March, with maximum parasitization (<20%) of *C. chlorideae*. Results show a fluctuation trend, as these parasitoids are density dependent in nature. As the host population increases, the parasitoid population also increases. Our results are in conformity with those of Pawar *et al.* [16] who collected larvae of *H. armigera* from the range of crops and weeds for the emergence of parasitoids in Andhra Pradesh and found that *C. chlorideae* was the most common parasitoid. It could be concluded from the present study that light traps are effective against the gram pod borer however the cost of the light traps, nature and importance of the other moths and the negative impact on the *C. chlorideae* population may be considered before commencing such practices.

Table 1: Meannumber of All Moths attracted-killed per trapped

Date	T1	T2	Mean
14/12/05	21.25	19.33	20.29
28/12/05	12.00	13.13	12.56
11/01/06	10.25	9.13	9.69
25/01/06	25.25	23.25	24.25
08/02/06	56.25	51.13	53.69
22/02/06	95.13	92.63	93.88
08/03/06	122.88	108.25	115.56
Mean	**49.00**	**45.26**	
± SD	44.43	40.29	

Table 2: Meannumber of Pod borer Moths attracted-killed per trapped

Date	T1	T2	Mean
14/12/05	2.08	0.75	1.42
28/12/05	0.50	0.13	0.31
11/01/06	0.00	0.00	0.00
25/01/06	2.25	1.75	2.00
08/02/06	7.50	5.25	6.38
22/02/06	19.50	16.50	18.00
08/03/06	21.13	14.88	18.00
Mean	**7.57**	**5.60**	
± SD	9.05	**7.13**	

Table 3: Mean number of the Adults of parasitoid per trap

Date	T1	T2	Mean
14/12/05	1.58	1.08	1.33
28/12/05	0.25	0.25	0.25
11/01/06	0.13	0.25	0.19
25/01/06	1.88	1.50	1.69
08/02/06	5.00	4.25	4.63
22/02/06	14.00	10.00	12.00
08/03/06	17.88	19.00	18.44
Seasonal Total	40.72	36.33	
Mean	**5.82**	**5.19**	
± SD	7.19	7.00	

Table 4: Mean number of larvae of gram pod borer (*Helicoverpa armigera*) per plant

Date	T1	T2	T3	Mean
14/12/05	0.498	0.485	0.478	0.487b
28/12/05	0.088	0.090	0.090	0.089e
11/01/06	0.060	0.053	0.075	0.063e
25/01/06	0.193	0.153	0.238	0.194d
08/02/06	0.203	0.155	0.263	0.207d
22/02/06	0.393	0.308	0.548	0.416c
08/03/06	0.713	0.535	0.965	0.738a
Mean	**0.306b**	**0.254c**	**0.379a**	

LSD at 5% for Means of populations on different dates = 0.0365
LSD at 5 % for Mean Treatment Effect = 0.0239
Means followed by the same letters are not significantly different from each other (P<0.05)

Table 5: Mean percent pod damage per plant in the five zones from light trap

Distance	T1	T2	T3	Mean
10m	3.52	2.53	10.14	5.39d
20m	4.16	3.11	10.56	5.94d
30m	5.44	3.71	10.60	6.58c
40m	6.48	4.70	10.59	7.26b
50m	7.72	6.08	10.11	7.97a
Mean	**5.46b**	**4.02c**	**10.4a**	

LSD at 5% for Means of populations on different dates = 0.0316
LSD at 5 % for Mean Treatment Effect = 0.477
Means followed by the same letters are not significantly different from each other (P<0.05)

Table 6: Mean Yield (kg ha^{-1}) in the five zones from the light trap

Distance	T1	T2	T3	Mean
10m	2004	2137	1856	1999a
20m	1992	2124	1854	1990a
30m	1975	2117	1857	1983a
40m	1965	2118	1794	1959b
50m	1963	2105	1808	1959b
Mean	**1980b**	**2120a**	**1834c**	

LSD at 5% for Means of populations on different dates = 19.37
LSD at 5 % for Mean Treatment Effect = 15.01
Means followed by the same letters are not significantly different from each other (P<0.05)

Table 7: Percentage parasitism of gram pod borer (*Helicoverpa armigera*) larvae

Date	T1	T2	T3	Mean
29/11/05	11.75	9.875	11.25	10.96b
14/12/05	8.125	6.625	10.25	8.333c
28/12/05	2.75	3.625	5.00	3.792de
11/01/06	1.75	2.00	4.75	2.833e
25/01/06	2.25	2.25	5.75	3.417de
08/02/06	3.625	4.25	7.00	4.958d
22/02/06	10.5	11.63	11.63	11.25b
08/03/06	15.38	15.75	16.75	15.96a
Mean	**7.016b**	**7.0b**	**9.047a**	

LSD at 5% for Means of populations on different dates = 1.90
LSD at 5 % for Mean Treatment Effect = 1.16
Means followed by the same letters are not significantly different from each other (P<0.05)

Table 8: Percent larval mortality of gram pod borer (*Helicoverpa armigera*)

Date	T1	T2	T3	Mean
29/11/05	7.125	6.125	8.125	7.125e
14/12/05	9.25	10.13	11.88	10.42cd
28/12/05	12.5	16.00	13.63	14.04a
11/01/06	12.75	12.25	14.75	13.25ab
25/01/06	10.5	12.00	12.00	11.5c
08/02/06	8.375	6.375	10.00	8.25e
22/02/06	8.75	9.5	8.00	8.75e
08/03/06	7.375	8.5	8.5	8.125e
Mean	**9.58b**	**10.11ab**	**1086a**	

LSD at 5% for Means of populations on different dates = 1.81
LSD at 5 % for Mean Treatment Effect = 1.11
Means followed by the same letters are not significantly different from each other (P<0.05)

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