IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 11, Issue 10 Ver. I (October. 2017), PP 84-86
www.iosrjournals.org

"Influence of lunar periodicity on the egg laying behavior of Helicoverpa armigera hubner (lepidoptera: noctuidae)

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Abstract *: Impact of lunar periodicity in ascending and descending phase of lunar cycle, moon disc illumination , moon light intensity and distance of moon from earth's meridian were assessed on egg laying behavior of moths of gram pod borer Helicoverpa argimera Hubner (Lepidotera : Noctuidae) in chickpea under field conditions . Percentage of egg laying was 42.98 higher in descending phase as compared to ascending phase. In ascending moon light reduces 24.61 per cent egg laying while in descending phase it enhance e 15.61 percent egg laying in cage A as compared to cage B. . Per cent moon disc illumination and moon light intensity was negatively correlated with number of eggs laid in descending phase of lunar cycle (r = - 0.668, r = - 0.860 and r = - 0.620 , r = - 0.889 respectively). Distance of moon from earth median was not correlated with egg laying behaviour of moth.*

Keywords: *Helicoverpa argimera, moon, ascending, descending, egg. etc*

Date of Submission: 25-09-2017 Date of acceptance: 07-10-2017

I. Introduction

Helicoverpa argimera Hubner (Lepidotera: Noctuidae) is a major pest of Chickpea causes loss upto 100 per cent It is strong photopositive and attracted towards various light sources Dillon and Mackinnon (2002). Like other Noctuidae egg laying in *Helicoverpa armigera* taking place during night hours. Presence of any natural or artificial scotopic illumination alters the phototactic response of the moths that influences the ovipositional behaviour under controlled conditions in *Agrotis segetum* Schiff Byers (1978). In *Mamestra brassica* (Lepidoptera: Noctuidae) maximum oviposition occurred during second hours of night (Rojas et al. 2001). Moon is the major natural source of the scotopic illumination and night illuminations have an impact on behaviour of Noctuidae. The size of light trap catch was influenced by the lunar phase (Vaishampayan and Verma 1982). The height of the moon above the horizon is in negative correlation with the number of the insect caught (Nowinszley 2004).in present investigation egg laying behaviour of *Helicoverpa armigera* was evaluated in ascending and descending phase of lunar cycle.

II. Material And Methods

Egg laying behaviour of the *Helicoverpa argimera* was studied under field conditions. Two types of field cages of (size 1.0 m x 1.0 x 1.0 m,) one covered with transparent nylon net allowed maximum amount of moon light to reached inside the cage (Cage A) and second cage covered with thick black cloth to prevent moon light penetration (Cage B)were used in study. In experimental site of chickpea field no artificial light was present. Moths of *Helicoverpa armigera* were collected carefully every morning from light trap, equipped with MV lamp and placed in a handy field cage in cool and dark area ten per cent sugar solution socked cotton was provided as a feed. Counted number of moths were released at evening hours in both types of cages fixed in a chickpea field. Next morning the moths were removed and eggs laid on gram plants were counted carefully plants were tagged. Next day the cages were fixed on other location just aside of the previous day's location in same field. This was continue up to two lunar cycles. The experiment replicated thrice.

Impact of scotopic illumination and its role in entertainment of egg laying rhythm in ascending and descending phase of lunar cycle was assessed on the basis of degree of moon disc illumination in different lunar nights, Intensity of moon light and distance of moon in different lunar night from the earth's meridian.

III. Results And Discussion

Egg laying behaviour in Ascending and Descending phase of lunar cycle:-

In Ascending phase eggs laid in cage A was 24.61 per cent less as compared to cage B. Hours of moon's illumination in different lunar night's had negative correlation with the eggs laid in field (Cage A) (r = - 0.486) in first half of first quarter (0.0 to 4.5 per cent moon disc illumination) eggs laid in cage A was not significantly correlated with cage B (r = -0.532) however, in second half of first quarter it was significant and negative (r = - 0.663). Maximum per cent of eggs (42.5per cent)were recorded when the moon light present up to third quarter of night followed by 26.99 per cent eggs laying when it was present in first quarter of night and in moon lit night (1800 – 0600 hours) eggs laid was 21.82 per cent.(table1&2.)

Difference in behaviour of egg laying in relation to scotopic moon's illumination was probably the result of relation to variation in per cent of moon disc illumination in different lunar nights reflected by light and the total period of absence of moon's illumination in different lunar nights in ascending phase which was 0.0 to 8.3 per cent and intensity of light 0.0 to 0.043 Lux recorded in first quarter of nights as compared to 61.66 to 82.10 per cent disc illumination and light intensity 0.153 to 0.127 Lux recorded in third quarter of nights indicated that the low intensity of moon light was not sufficient to influence significantly the egg laying behaviour of moths coupled with its duration in different quarter of nights. Daans and Aschoff J. 2001 stated that the dim nocturnal illumination may substantially alter the entrainment to bright light regimes.

Descending phase is characterized by the increasing trend of scotophase hours in early hours of nights presence of scotophase enhanced the egg laying by 15.61 per cent and the correlation was positive and significant in Cage A and B (r = 0.347). Scotophase enhances the egg laying in moths when it coincides in early hours of night. Similar finding also reported by Rojas et al (2001) in case of *Mamestra branica*. In first half of first quarter in ascending phase, the moon light was dim and insufficient to reset the phase of circadian clock Daans and Aschoff J. 2001 directly due to this the eggs laying was not influenced significantly in the period but it had some impact as compared to total darkness.

Moon disc illumination and egg laying behavior:-

Correlation between egg layings in Cage A and per cent moon disc illumination was non significant (r = -0.571 and r = -0.185) in first and second half of the first quarter in ascending cycle. While it was negatively significant in descending cycle r = - 0.668 and r = - 0.860 respectively. Probably due to per cent moons disc illumination was minimum in second half of third quarter of lunar cycle coupled with the scotopic hours from 18.57 hours to 00.30 hours. Low moon disc illumination (ascending phase)in early hours of night had no impact on egg laying while in descending phase early scotopic hours coupled with reducing percentage of moon disc illumination enhanced the egg laying. Finding confirmed the findings as reported by Byers(1987) and Michael et al (2005)

Distance of moon from earth surface (meridian) and egg lying behaviour :-

It varies from 4,05,387 to 3,59,122 km from the earth's meridian. Egg laying was not influenced by the moon distance from the meridian (r = - 0.110 and r = 0.191) in ascending and descending phase respectively. Probably due to the fact that the distance of moon increases with the decrease of disc illumination hence during higher disc illumination moon became nearer to the earth. This was the period of lunar cycle when egg laying was suppressed due to moon light, on the other hand when disc illumination was minimum the moon remains further away from the earth meridian. In this period the egg laying was enhanced not because of moon distance but probable due to low disc illumination. Thus effect of moon distance affects the light intensity not the egg laying intensity.

Influence of moon light intensity on egg laying behaviour:-

Intensity of moon light was measured in Lux. and converted into per cent illumination considering 100 per cent illumination at full moon. in ascending phase first and second half of first quarter the egg laying was not correlated with moon intensity (r = 0.570 and r = - 0.229) as in early hours of night the moon present in the sky while in descending phase moon rise gradually delayed in each hours of night so the scotophase hours were in early hours of night. The correlation was negative but significant r = -0.620 and r = - 0.889 in first and second half of third quarter of lunar cycle respectively. Dcans and Aschoff J. 2001 discussed Entrainment of circadian rhythms in circadian clocks, endogenously generated circadian rhythms are synchronized with the environment through phase resetting action of light. Starlight and moon light are of insufficient intensity to reset the phase of clock directly, but recent studies have indicated that the dim nocturnal illumination may otherwise. Substantially alter entrainment to bright lighting regims.

Table 1: Changes in moon's illumination in ascending phase of lunar cycle and its influence on egg laying rhythm of *Helicoverpa argimera* in chickpea.

S.no.	Moon Phase	Per cent moon disk Illumination	Moon Illumination hours from 1800 hr.	Moon distance from meridian (in lac km.)	Moon light intensity (in Lux)	Moon light intensity (Converted into 100 scale)	Eggs laid in Cage A	Eggs laid in Cage B
1.	New Moon	0.0	0.0	4,05,387	0.0	0.0	20.0	30.0
2.	First Quarter	0.9	0.55	4,06,243	0.0027	0.899	6.0	32.0
3.		3.7	1.46	4,06,405	0.0114	3.799	28.0	10.0
4.		8.3	2.36	4,05,778	0.025	8.333	35.0	10.0
5.		14.4	3.26	4,04,258	0.0433	14.433	25.0	14.0
6.		22.0	4.16	4,01,756	0.066	21.999	15.0	8.0
7.		30.7	5.07	3,98,222	0.092	30.666	5.0	6.0
8.		40.5	6.00	3,93,665	0.121	40.333	2.6	60.5
9		50.9	6.57	3,88,180	0.1532	51.066	10.0	50.0
10.		61.6	7.56	3,81,983	0.1855	61.833	40.0	28.0
11.		72.2	8.54	3,75,437	0.217	72.353	61.0	2.0
12.		82.1	10.01	3,69,061	0.247	82.333	12.0	90.0
13.		90.4	11.02	3,63,472	0.2722	90.733	36.0	8.0
14.		96.5	11.02	3,59,282	0.2906	96.666	14.0	52.0
15.		97.0	11.08	3,59,282	0.292	97.333	14.0	17.0
16.	Full Moon	99.6	12.27	3,56,972	0.300	100.00	19.0	10.0

Table 2: Changes in moon's illumination in descending phase of lunar cycle and its influence on egg laying rhythm of *Helicoverpa argimera* in chickpea.

S.no.	Moon Phase	Per cent moon disk Illumination	Scoto phase hours from 1800 hr.	Moon distance from meridian (in lac km.)	Moon light intensity (in Lux)	Moon light intensity (Converted into 100 scale)	Eggs laid in Cage A	Eggs laid in Cage B
16	Full Moon	99.6	0.0	3,56,972	0.300	100.000	19.0	10.0
17	Third Quarter	99.5	1.29	3,56,800	0.299	99.666	20.0	4.0
18		96.1	2.34	3,58,760	0.289	96.333	62.0	18.0
19		89.8	3.36	3,62,594	0.270	89.999	15.0	82.0
20		81.3	4.37	3,67,847	0.244	81.599	35.0	30.0
21		71.4	5.38	3,73,956	0.215	71.666	30.0	7.0
22		60.6	6.00	3,80,344	0.185	61.733	116.0	60.0
23		49.8	6.37	3,86,509	0.150	49.999	10.0	3.0
24		39.2	7.35	3,92,079	0.118	39.333	19.0	15.0
25		29.4	8.32	3,96,817	0.088	29.333	30.0	20.0
26		20.7	9.24	4,00,605	0.039	13.299	50.0	10.0
27		13.3	10.13	4,03,415	0.024	13.333	26.0	38.0
28		7.4	10.57	4,05,287	0.022	7.399	45.0	18.0
29		3.1	11.37	4,06,296	0.002	0.633	60.0	95.0
30	New Moon	0.7	12.13	4,06,534	0.002	0.666	45.0	75.0

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Swati Singh. ""Influence of lunar periodicity on the egg laying behavior of Helicoperva armigera hubner (Lepidoptera: noctuidae)." IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT), vol. 11, no. 10, 2017, pp. 84–86.