The Pharma Innovation Journal 2021; SP-10(10): 989-991

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; SP-10(10): 989-991

www.thepharmajournal.com
Received: 16-08-2021
Accepted: 15-09-2021

Subhalaxmi Roy
Assistant Professor, Department of Entomology, Institute of Agricultural Sciences, SOADU, Bhubaneswar, Odisha, India

Bijoy Kumar Mishra
Professor and Head, Department of Entomology, Institute of Agricultural Sciences, SOADU, Bhubaneswar, Odisha, India

Corresponding Author
Subhalaxmi Roy
Assistant Professor, Department of Entomology, Institute of Agricultural Sciences, SOADU, Bhubaneswar, Odisha, India

Influence of seasonal changes on the biology of Brinjal shoot and fruit borer *Leucinodes orbonalis* (Guenee) in Odisha

Subhalaxmi Roy and Bijoy Kumar Mishra

Abstract
Laboratory experiments was carried out in the Department of Entomology, Institute of Agricultural Sciences, SOADU during 2017-2018. Correlation between weather parameters and biological parameters indicated highly significant correlation between maximum temperature, minimum temperatures, humidity and rainfall with the biology of Leucinodes orbonalis in brinjal. The experiment was laid out in a Complete Randomized Block Design. The incubation period was highest with (6.7 days) during December to January in 2016 and lowest incubation period of (4.0 days) during May to June 2015. The total larval period ranged between a minimum of 13.40 days in May-June to a maximum of 16.80days in December-January. Adult longevity and fecundity of *L. orbonalis* revealed that males live for a maximum of 4.9±0.1 days whereas the shortest longevity of males was found in the month of May-June (1.6±0.2) days. Accordingly the total longevity was longest (7.1±0.1) days was in December- January and the shortest one (3.2±0.5) was found in May-June.

Keywords: Weather, biology, correlation coefficient, brinjal shoot and fruit borer

Introduction
Vegetables serve as an important source of vitamins, minerals and plant proteins in human diets throughout the world. Vegetables are rapidly becoming an important source of income for the rural population. Brinjal, Solanum melongena L, is one such typical vegetable and its commercial cultivation not only helps to improve human nutrition, but also increase income generation for the grower. In the hot wet monsoon season when other vegetables are in short supply, brinjal is practically the only vegetable that is available at an affordable price for rural and urban poor. The area under brinjal cultivation in India is estimated at 7.22 lakh ha under cultivation with a production of 134.43 metric tons and productivity of 18.60 tonnes per hectare. In Karnataka, brinjal is cultivated over an area of 16.10 thousand ha with a production of 421.40 thousand tones (Annon, 2014) [1]. Brinjal plants are very much susceptible to insect pests attack right from seedling stage to final harvesting stage. Brinjal is attacked by 53 species of insect pests of which 8 are considered as major pests causing huge damage to crop in every season in every year (Biswas *et al.*, 1992) [2]. Among the major insect pests, brinjal shoot and fruit borer (BSFB), Leucinodes orbonalis is considered the most destructive pest of brinjal in India. The yield loss due to the pest is to the extent of 70-92 per cent (Eswara Reddy and Srinivas, 2004; Jagginavar *et al.*, 2009; Chakraborti and Sarkar, 2011) [4, 6, 3].

Material and Methods
Brinjal is one of the most commonly grown and economically important vegetables of Odisha and the shoot and fruit Borer, *Leucinodes orbonalis* (Guenee) is the key insect reduces both the production and productivity of this vegetable crop. Laboratory studies were conducted to reveal the seasonal activity on the biological parameters of *L. orbonalis* during 2017-18 in the Department of Entomology, Institute of Agricultural Sciences, SOADU, Bhubaneswar.
The biology of *L. orbonails* was studied in the laboratory of the Department of Entomology, in ambient environmental condition of 25º±1ºC and 70 ± 2% RH. Field collected infested fruits were kept in acrylic cages of 60×60×60cm for the emergence of the moths. Moths were collected after emergence and kept in glass jars of 15cm×10cm for egg laying. About 50 moths were kept in one jar and they were fed with 10% honey solution in cotton swabs. The mouths of the jars were tightly closed by muslin cloths and rubber bands. Moths laid eggs on the muslin cloth and the eggs were collected along with the cloth every day.

The eggs were observed for hatching and after hatching, the neonate larvae were transferred to cut potato pieces for study of biology of the pest. Fresh sliced piece of potato was provided to the larvae on every alternate day. Prior to the rearing of *L. orbonalis* larvae, the acceptance of potato tubers as food by the insect was examined by releasing a few larvae on sliced end of a well washed potato tubers. Biology of *L. orbonalis* was studied by examining different stages of the insect under microscope. The biology of *L. orbonalis* was studied in different months of the year under different temperature and humidity regimes. The temperature and humidity prevailing at the particular period of the year were simulated in the laboratory using a BOD incubator. Altogether, 10 generations were studied in twelve months of the year.

Egg: Daily observations were recorded to determine the incubation period and hatchability of the eggs. One hundred fresh eggs were taken in a petridish on filter paper to record the incubation period and hatchability. Ten replications were maintained. The observations were taken in different periods of the year.

Larva: Observations were recorded on the number of larval instars. Daily observations were recorded to determine the duration and survival of respective larval instars. Ten neonate larvae were taken in a petridish (10cm diameter) on cut potato slices. Everyday larvae were removed from the petridishes to new petridishes and fresh food was provided. Observations on moulting and total period taken for each instar were recorded. Ten replications were maintained.

Pupa: Ten fresh pupae were taken in a petridish to record the pupal period. Ten replications were maintained and the pupal period was recorded.

Adult: Adult longevity was studied by taking ten freshly emerged adults in one glass jar (15×10 cm) and covering the mouth with muslin cloth. Each day the mortality of the adults were recorded. Ten replications were maintained Fecundity of the adults was studied by enclosing one pair of freshly emerged adult (male and female) in a glass jar (15×10 cm) with the mouth covered by black muslin cloth. They were provided with 50% honey on cotton swabs as food. Eggs were laid on the cloth and were counted daily to record fecundity. Hatchability was recorded, by taking 100 freshly laid eggs in petridishes and observing the hatching.

The meterological data during the study of biological parameters were correlated with the total developmental period of *L. orbonalis*. The parameters like maximum temperature, minimum temperature, mean temperature and relative humidity were correlated with the different developmental stages and correlation coefficient was determined.

Statistical analysis: All the data thus, collected from the experiments were recorded in respect of the above insect over the periods of observations were subjected to analysis of variants for drawing inference using standard statistical procedures (Gomez and Gomez, 1984) [5].

Results and Discussion

The effect of weather on the biology of *L. orbonalis* during different periods of the year are shown in Table 1 and the correlation of weather factors with incubation period is presented in Table 1 a. The correlation of weather parameters on the incubation period of *L. orbonalis* exhibited highly negative correlation (r = -0.723) with mean temperature during the study period indicating that with the increase and decrease of temperature, the incubation is severely affected. The correlation with relative humidity was negative but non-significant. The incubation period was highest with (6.7 days) during December to January in 2018 and lowest incubation period of (4.0 days) during May to June 2017. The total larval period ranged between a minimum of 13.40 days in May-June to a maximum of 16.80days in December-January. The correlation was negative and highly significant (r=-0.807) with mean temperature and significant (r=-0.430) but negative with mean relative humidity (Table 1a). Effect of weather parameters on the pupal period of *L. orbonalis* indicated highly significant negative correlation with mean temperature (r=-0.866) and negative non-significant (r=-0.125) with relative humidity. Similarly the correlation with adult male and female longevity were highly negatively significant (r=-0.866 and -0.853) with the mean temperature respectively. Non-significant negative correlation was found with relative humidity (Table 1a). The correlation between weather parameters and fecundity revealed highly non-significant correlation with temperature (r=-0.788) and non-significant with relative humidity (r=-0.140) in Table 1a. The correlation between weather parameters, total longevity of *L. orbonalis* resulted in a highly non-significant correlation (r=-0.768) with mean temperature and significant negative correlation (r=-0.379) with mean relative humidity in Table 1a. Adult longevity and fecundity of *L. orbonalis* revealed that males live for a maximum of 4.9±0.1 days whereas the shortest longevity of males was found in the month of May-June (1.6±0.2) days. Similar observations were found in the pre-oviposition, oviposition and post-oviposition periods where the shortest period was in May-June and longest periods recorded in December- January. Our observations are in agreement with Singh *et al.* (2009) [8]. This again confirmed that the duration of life periods are longer in the cooler months and shorter in the warmer months. Accordingly the total longevity was longest (7.1±0.1) days was in December-January and the shortest one (3.2±0.5) was found in May-June. The fecundity also corroborated the same trend. Maximum number of eggs (180.3±0.28) being laid during December- January and minimum number of eggs (21.0±0.30) being laid in May-June. The correlation of weather parameters with fecundity also confirmed that the life events are longer in cooler months and shorter in warmer months by showing a highly significant negative correlation with temperature (-0.723). Similar correlation also found in the duration of larval and pupal period with temperature. Similar correlation was also found between temperature, pupal longevity, longevity of males and females where again significant negative correlation with mean temperature was found. Detail observations in our study agrees with the findings of Mathur *et al.* (2011) [7].

Table 1a: Correlation between weather parameters on the biology of *L. orbonalis* in 2017-2018

Parameters	coefficient (r) during 2017- 2018						
	Incubation period	**Larval longevity**	**Pupal period**	**Adult male**	**Adult female**	**Fecundity**	**Total longevity**
Mean temperature(℃)	-0.723**	-0.807**	-0.866**	-0.866**	-0.853**	-0.788**	-0.768**
Mean relative humidity (%)	-0.380	-0.430*	-0.125	-0.007	-0.287	-0.140	-0.379

**Significant at P=0.01
*Significant at P=0.05

Table 1: Effect of weather parameters on the biology of *L. orbonalis* in different periods of the year 2017-18

Generation	Period	Mean Temperature (℃)	Mean Relative Humidity (%)	Mean Incubation Period (days)	Larval period	Pupal period	Adult longevity		Fecundity	Total longevity
							Female	Male		
I	Feb.9 – March 9, 2017	25.7	60.9	5.9	16.30	7.20	5.20	3.40	159.40	29.40
II	March 12 – April 8	31.2	62.3	5.8	15.80	7.80	4.10	2.60	139.00	28.16
III	April 13 – May 8	32.1	69.7	5.2	14.10	7.00	3.60	1.90	70.60	26.30
IV	May14 –June 7	32.2	70.6	4.0	13.40	5.40	3.20	1.60	21.00	22.80
V	June 10 – July 2	30.0	81.0	4.1	14.00	5.90	3.50	1.80	42.20	24.00
VI	July 5 – July 29	29.0	88.0	4.5	14.00	6.70	3.80	2.50	127.40	25.20
VII	August 3 – Aug.25	28.9	85.0	4.8	15.20	6.80	4.10	3.30	128.00	26.80
VIII	Sept.2– Oct 05	28.3	86.3	6.1	15.20	7.50	4.70	3.70	134.60	28.80
IX	Oct. 12 – Nov.23	25.1	77.4	6.2	16.00	8.00	5.80	4.00	162.50	30.20
X	Dec. 02 –Jan. 27, 2018	22.1	65.8	6.7	16.80	8.50	7.10	4.10	180.30	32.00

Conclusion

Differential climatic condition brings about differential metabolic activities and it leads to different gradients of longevity of different stages of *L. orbonalis*. The same point was further illustrated by the highest survival rate of different life stages in December-January and the lowest survival rate in May-June. The fecundity of *L. orbonalis* also followed the same trend, maximum eggs being laid in December-January whereas the minimum egg was laid in May-June. The correlation of different weather parameters also confirmed the findings. It was revealed that there was highly significant negative correlation of duration of different life stages, fecundity, longevity of different instar of larvae, pupae and adults with temperature and relative humidity.

Acknowledgement

The authors gratefully acknowledge the help rendered by the Head of the Department, Department of Entomology, Institute of Agricultural Sciences, SOADU, Bhubaneswar, for providing necessary laboratory facilities for conducting the experiments.

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