International Journal of Bio-resource and Stress Management 2014, 5(3):409-412
DOI:10.5958/0976-4038.2014.00589.2

Short Research Article

Seasonal Variation in the Larval Population of Brinjal Shoot and Fruit Borer *Leucinodes orbonalis* Guenee with Respect to Different Ecological Parameters

U. S. Nayak[1*], K. Baral[2], P. Mandal[2] and S. Chatterjee[3]

[1]Krishi Vigyan Kendra (OUAT), Ranital, Bhadrak, Odisha (756 100), India
[2]Palli Siksha Bhavana, Visva Bharati, Sriniketan, West Bengal (731 235), India
[3]Rice Research Station, Chinsurah (R.S.), Hooghly, West Bengal (712 101), India

Article History

Manuscript No. AR691
Received in 17th July, 2014
Received in revised form 16th July, 2014
Accepted in final form 19th July, 2014

Correspondence to

**E-mail*: usnayak74@gmail.com

Keywords

Brinjal, ecological parameters, larval population, *Leucinodes orbonalis*

Abstract

The study on the variation in larval population of brinjal shoot and fruit borer (BSFB), *Leucinodes orbonalis* Guene was carried out during rainy, winter and summer seasons of 2009-10 and 2010-11 at Keonjhar district of Odisha under field conditions. During rainy season, the larval infestation initiated in last week of June and increased progressively with two distinct peak level. The first peak was observed during 2nd and 3rd week of August and the second one was attained during 3rd week of September and 1st week of October, respectively in 2009 and 2010. In the winter season, the larvae of BSFB appeared for the first time 4th week of October with two subsequent peak population level during the crop growth period. The initial peak was attained during 3rd and 1st week of December for 2009-10 and 2010-11, respectively and the subsequent peak was observed at 3rd week of February for both the years of study. In contrast, in the summer season the larvae of BSFB first appeared on 4th week of January during both the years of trial and registered an increasing trend to attain two well defined peaks during the crop growth period. The first peak larval population was observed during 1st fortnight of April followed by the second peak during 3rd week of May. Among the ecological parameters temperature exerted positive and relative humidity had negative influence on the pattern of larval population variation. These two weather variable had maximum contribution towards the variation in larval intensity.

1. Introduction

Brinjal, *Solanum melongena* L. is one of the major vegetables in India extensively grown under diverse agro-climatic conditions throughout the year. The brinjal shoot and fruit borer (BSFB), *Leucinodes orbonalis* Guenee (Pyralidae: Lepidoptera) is the most important insect pest of brinjal and the apparent yield loss varying from 20-90% in various parts of the country (Raju et al., 2007). The caterpillar on hatching attacks the young plants by boring into the tender shoots, petioles and midribs of large leaves and later bore into flower buds and fruits. Inside the fruits they feed the internal tissues by making tunnels and close the opening with excreta and thereby reduce the market quality of fruits. Farmers mostly rely on the repeated application of chemical pesticides to minimize the pest incidence. But being an internal borer with an ability to develop resistance to many insecticides of diverse mode of action, this pest has been very difficult to manage with insecticides. Moreover, as a result of the excessive and indiscriminate use of various synthetic insecticides alone and in combination pose a serious adverse impact on the human health and surrounding environment. Hence, early detection of the pest and reduction of the damage level at the peak infestation stages through deliberate plant protection measures is of utmost importance. For development of cost effective management strategies against this insect, detailed information on its seasonal variation and the influence of weather factors on the population dynamics is of great significance. As the pattern of larval infestation varies from season to season and from location to location, in the present investigation attempts were made to monitor the patterns of larval incidence on the crop in different seasons.

2. Materials and Methods

The seasonal variation in the larval incidence of brinjal shoot and fruit borer (BSFB) was studied from the unprotected brinjal plots of 50 m^2 area in the instructional farm of Krishi Vigyan Kendra, Keonjhar, Odisha during rainy, winter and summer seasons of 2009-10 and 2010-11. Thirty days old seedlings of brinjal (cv. Blue Star) were transplanted during 5th June to 8th June (rainy season crop), 3rd to 5th October (winter crop) and 9th to 12th January (summer crop) with the standard agronomic package of practices. Weekly larval population of BSFB from all sources *viz*. shoot, flower bud and fruit was recorded as average number of larvae plant^{-1} week from 10 randomly selected plants from the initiation of damage and expressed as larval intensity. The ecological parameters like maximum temperature, minimum temperature, relative humidity (morning and evening) and rainfall were collected from the meteorological observatory, Regional Research and Technology Transfer Station, Keonjhar located at 50 m from the experimental site for two years of study. The influence of these abiotic factors was correlated with the larval intensity to know their relationship whereas regression analysis was taken up to ascertain the contribution of each abiotic factor on the pattern of larval population build up. In all the cases of analysis, the abiotic factors prevailed during the previous standard week were correlated and regressed with the larval intensity recorded in the succeeding week.

3. Results and Discussion

3.1. Seasonal variation in the larval population of BSFB

During rainy season the larval infestation initiated from 26th standard meteorological week (SMW) (last week of June) i.e. 22 and 24 days after transplanting (DAT) in both the years of study, respectively and increased progressively thereafter (Figure 1). During 2009 the first peak larval activity (2.5 larvae plant^{-1} week^{-1}) was observed during 32nd SMW (2nd week of August) while the second peak (2.9 larvae plant^{-1} week^{-1}) was noticed during 38th SMW (3rd week of September). However, in 2010 the larval population attained its first highest number (2.4 larvae plant^{-1} week^{-1}) during 33rd SMW (3rd week of August) and the subsequent higher density (2.7 larvae plant^{-1} week^{-1}) was noticed at 40th SMW (first week of October). The present findings are in accordance with Patial and Mehta (2008) who reported from Palampur (Himachal Pradesh) that during rainy season BSFB reached its peak on 22nd September during the first year of investigation (2003) and during 2004 the pest attained its peak on 11th August. The results were further substantiated with the findings of Shukla and Khatri (2010) who reported from Kanpur that in the peak larval population of *L. orbonalis* was recorded from 3rd week of September to 3rd week of October and it declined from 3rd week of November.

During winter season (Figure 2), the larvae of BSFB appeared for the first time in 43rd SMW (4th week of October) i.e. 25 DAT in 2009-10 and 42nd SMW (3rd week of October) i.e. 18 DAT during 2010-11 and the larval population increased thereafter with two distinct highest levels. In 2009-10 the larval intensity attained its first peak (2.1 l arvae plant^{-1} week^{-1}) during 51st SMW (3rd week of December) and the second peak (2.3 larvae plant^{-1} week^{-1}) was observed during 8th SMW (3rd week of February). In the second year the first peak of larval population (1.9 larvae plant^{-1} week^{-1}) was at 49th SMW (first week of December) while the second peak (2.6 larvae plant^{-1} week^{-1}) was attained at 8th SMW (3rd week of February). The present findings corroborate with the findings of Samal (2008) who reported from Bhubaneswar condition that in winter season the larvae of different instars peaked during 7th SMW coinciding with the flowering and fruiting stage of the crop.

In summer season (Figure 3) the larvae of *L. orbonalis* appeared from 4th SMW (4th week of January) i.e. 18 DAT in both the years of trial and registered an increasing trend to attain two well defined peaks during the crop growth period. In 2010, the first peak larval population was observed during 15th SMW

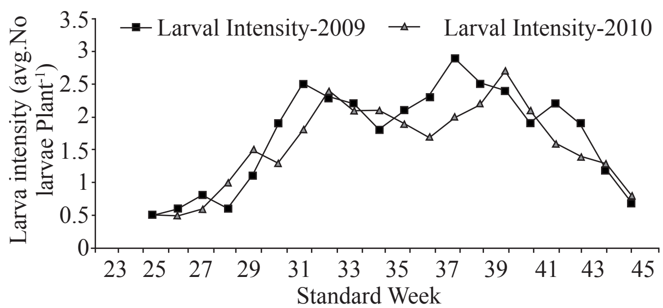

Figure 1: Seasonal trend of larval intensity during rainy season of 2009 and 2010

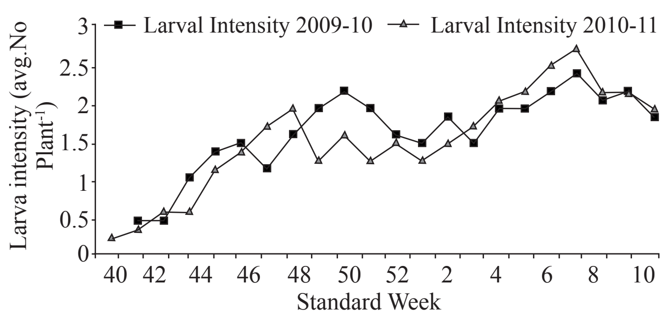

Figure 2: Seasonal trend of larval intensity during winter seasons of 2009-10 and 2010-11

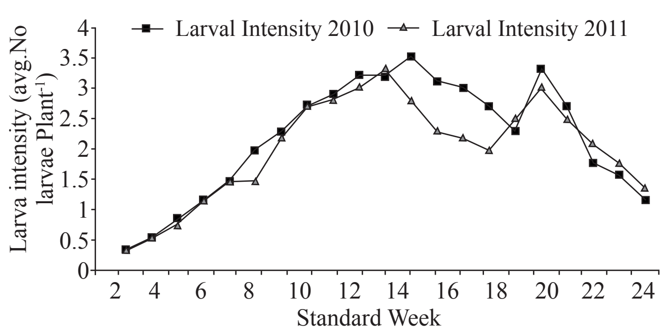

Figure 3: Seasonal trend of larval intensity during summer seasons 2010 and 2011

(2nd week of April) with significantly higher larval intensity (3.4 larvae plant^{-1} week^{-1}) followed by the second peak (3.2 larvae plant^{-1} week^{-1}) during 20th SMW. However, during 2011, the first peak larval intensity (3.2 larvae plant^{-1} week^{-1}) was attained at 14th SMW (1st week of April) followed by second peak (2.9 larvae plant^{-1} week^{-1}) at 20th SMW (3rd week of May). The results derive ample support from the findings of Naresh et al. (1986) who recorded maximum larval population of *L. orbonalis* during the month of May. Samal (2008) further reported that during summer season larval peak of all instars were noticed during the late vegetative to flowering stage in the 14th SMW.

3.2. Correlation of ecological parameters with the abundance and infestation of BSFB

The influence of different ecological parameters on the larval incidence of BSFB was assessed by the multiple correlation analysis and depicted in Table 1. During rainy season all the abiotic factors except rainfall had positive correlation with the average larval population per plant. However, during 2010 only the minimum temperature exhibited a significantly positive correlation (r=0.533) with the larval intensity and the other abiotic parameters failed to establish any clear cut relationship.

During winter 2009-10 maximum temperature and average temperature had a positive and other weather parameters including minimum temperature had a negative correlation with the larval intensity. However, these correlations were not statistically significant. But during the subsequent year i.e. 2010-11, though a similar trend of correlation observed, a significant positive correlation existed with maximum temperature (r=0.454) and significant negative correlation was recorded with relative humidity (r=-0.684 and -0.804, respectively for morning and afternoon) and rainfall (r=-0.453).

However, during summer seasons of both the year of study, a significant positive correlation was observed between temperature (maximum, minimum and average) and larval intensity (r=0.595 to 0.871). The relative humidity had negative effect on the larval population of *L. orbonalis* with significant correlation coefficient values (r=-0.816 and -0.682, respectively for morning and afternoon) during 2010 and non-significant values during 2011. The role of rainfall on larval intensity was not at all conspicuous. The present findings are in accordance with the findings of Shaha et al. (1995) who reported that the larval population of *L. orbonalis* and its incidence was positively correlated with maximum and minimum temperature.

3.3. Multiple interaction of ecological parameters on the larval incidence pattern of BSFB

The multiple effects of ecological parameters on the larval intensity of BSFB were studied through multiple regression analysis. It was observed that during rainy season of 2009 (Table 2), 43.8% variation in larval population level was contributed by the abiotic factors under study (R^2=0.438). Among the ecological parameters maximum temperature made the major contribution towards the larval population fluctuation (47.21%) followed by relative humidity (morning) with 41.42% contribution, while the other parameters had very negligible effect. However, during the subsequent year, the overall impact of these weather factors on the larval population abundance of the pest was estimated to be 55.8% (R^2=0.558) and minimum temperature played a major role (62.70%) followed by maximum temperature (28.24%).

During winter, 2009-10, the overall impact of all the weather factors on the larval intensity is found to be only 31.2% (R^2=0.312) and maximum temperature exerted major influence (43.24%) followed by minimum temperature (40.34%) on the larval population level. The relative humidity played some role with 10.43 and 5.76% contribution from R.H (Afternoon) and R.H (Morning) respectively, whereas the contribution from rainfall was very negligible. However, during 2010-11 the influence of climatic factors as a whole, on the larval intensity is estimated to be 71.1% (R^2=0.711) and relative humidity imposed a maximum influence with 63.98% contribution from RH (Afternoon) and 20.51% contribution from RH (Morning). In contrast to the first year study, maximum temperature had only 10.97% influence on the larval population abundance followed by average temperature (4.51%).

During summer, 2010 the larval population of *L. orbonalis* was significantly influenced by various weather factors as evidenced by the higher coefficient determination value

Table 1: Correlation between the ecological parameters and larval intensity of BSFB in different seasons

Abiotic factors	Correlation coefficient (r)					
	Kharif		Rabi		Summer	
	2009	2010	2009-10	2010-11	2010	2011
Maximum temperature (° C)	0.026	0.214	0.162	0.454*	0.871*	0.642*
Minimum temperature (° C)	0.146	0.533*	-0.094	-0.371	0.692*	0.595*
Average temperature (° C)	0.109	0.412	0.047	0.092	0. 797*	0.626*
Rainfall (mm)	-0.059	-0.020	-0.073	-0.453*	-0.060	0.201
RH (%) (Morning)	0.253	0.161	-0.196	-0.684*	-0.816*	-0.214
RH (%) (after noon)	0.246	0.134	-0.153	-0.804*	-0.682*	-0.276

Table 2: Contribution of ecological parameters on the larval intensity of BSFB

Seasons	Coefficient of determination (R^2)	Prediction equation	% contribution[#]					
			Max. temp. (°C)	Min. temp. (°C)	Avg. temp. (°C)	Rainfall (mm)	RH % (morning)	RH % (after noon)
Kharif 2009	0.438	$Y=-22.802+0.483X_1-0.134X_2-0.034X_4+0.137X_5-0.026X_6$	47.21 (1.612)	6.65 (-0.605)	-	2.84 (-0.395)	41.42 (1.510)	1.88 (0.387)
Kharif 2010	0.558	$Y=2.756-0.361X_1+0.394X_2-0.03X_4-0.021X_5-0.039X_6$	28.24 (-0.920)	62.70 (1.371)	-	3.63 (-0.330)	1.18 (-0.188)	4.25 (0.357)
Rabi 2009-10	0.312	$Y=-2.660+0.188X_1-0.216X_2-0.056X_4-0.041X_5+0.082X_6$	43.24 (1.230)	40.34 (-1.188)	-	0.23 (-0.089)	5.76 (-0.449)	10.43 (0.604)
Rabi 2010-11	0.711	$Y=2.567+0.111X_1-0.077X_3+0.008X_4+0.006X_5-0.108X_6$	10.97 (0.504)	-	4.51 (-0.323)	0.04 (0.031)	20.51 (0.689)	63.98 (-1.217)
Summer 2010	0.848	$Y=-7.558+0.371X_1-0.191X_2+0.059X_4+0.013X_5-0.009X_6$	76.42 (1.771)	22.27 (-0.956)	-	1.034 (0.206)	0.164 (0.082)	0.109 (-0.067)
Summer 2011	0.562	$Y=1.905+0.136X_1-0.015X_2+0.123X_4+0.05X_5-0.135X_6$	23.00 (0.555)	0.41 (-0.074)	-	14.72 (0.444)	8.68 (0.341)	53.19 (-0.844)

#Contribution of different abiotic factors to larval intensity

(Figures in the parentheses are the standardized partial regression coefficient values, β)

Y=Larval Intensity

X_1=Maximum Temperature (°C)

X_2=Minimum Temperature (°C)

X_3=Average Temperature (°C)

X_4=Rainfall (mm)

X_5=Morning Relative Humidity (%)

X_6=Afternoon Relative Humidity (%)

Note: *Per cent contribution of individual abiotic factor* = $[(\beta_i)^2 / \sum (\beta_i)^2 \ldots\ldots\ldots(\beta_j)^2]\ X\ 100$

(R^2) of 0.848. Major contribution to the variation of larval population was exerted by maximum temperature (76.42%) followed by minimum temperature (22.27%), whereas, other abiotic factors have very negligible effect on it. However, in 2011, the coefficient determination value (R^2) was found to be 0.562, indicating the contribution of all the abiotic factors on the larval population fluctuation was 56.2%. Among the weather variables RH (Afternoon) had maximum impact (53.19%) on the larval intensity of BSFB, followed by maximum temperature (23.0%), rainfall (14.72%) and RH (Morning) (8.68%).

4. Conclusion

Maximum field larval population of brinjal shoot and fruit borer prevailed during the month of August to October in rainy season, during December to February in winter and during March to May in summer season with two distinct peak incidence stages in each season. Among the ecological parameters temperature in general exerted positive and relative humidity had negative influence on the pattern of larval population variation of BSFB. These two weather variables had maximum contribution towards the seasonal fluctuation in larval population build up of the pest.

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