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POPULATION DYNAMICS OF BRINJAL SHOOT AND FRUIT BORER, *LEUCINODES ORBONALIS* GUENÉE (LEPIDOPTERA: CRAMBIDAE) UNDER AGROCLIMATIC CONDITIONS OF HISAR, HARYANA, INDIA

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ABSTRACT

Population dynamics of brinjal shoot and fruit borer (BSFR) (*Leucinodes orbonalis* Guenée) on brinjal crop was studied during summer 2009-10 on brinjal variety BR-112 at the research farm of Chaudhary Charan Singh Haryana Agricultural University, Hisar (Haryana), India. The incidence of pest population was recorded on shoots as well as fruits of brinjal crop. Maximum numbers of larvae (10 larvae/90 plants) were recorded in the 39th and 40th standard weeks of 2009. Two abiotic factors such as weekly temperature and percent relative humidity (%RH) were correlated with the population of BSFR on brinjal. The BSFR infestation is likely to be influenced by maximum temperature. The prevalence of low temperatures may be a cause for lengthening the life cycle of this pest, while at elevated temperatures this pest completes the life cycle at a comparatively shorter duration. The BSFR appeared from 38th standard week and increased progressively up to 40th standard week. The maximum mean larval population (10 larvae/90 plants) of BSFR was observed at 40th standard week whereas the lowest mean population (0.0/90 plants) of BSFR was recorded in 48th standard week. Therefore, it is concluded that the caterpillar populations are positively correlated with temperature. However, it is negatively correlated with % RH.

KEY WORDS
Leucinodes orbonalis Guenee
Brinjal
Population dynamics
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INTRODUCTION

Vegetables are essential components of human diet due to their high nutritional value. Nutritive value per 100 g of raw brinjal indicates that it supplies 25 calories, 0.2 gm total fat, 2 mg sodium, 229 mg potassium, 6 gm total carbohydrate, 3 gm dietary fiber, 3.5 gm sugar, 1 gm protein, vitamins (B-6, B-12 and C), iron, magnesium, phosphorus, etc. (USDA, 2013).

Brinjal, also known as eggplant or aubergine, belongs to the Solanaceae family. This family contains more than 2450 plant species distributed in 95 genera (Mabberley, 2008). The first written record of brinjal could be found in the Chinese agricultural treatise (Qímínyàoshù) written in 544 A.D. (Dunlop, 2006). Tsao and Lo (2006) and Doijode (2001) considered brinjal is native to the Indian subcontinent. The global area under brinjal cultivation was 2.097 million hectares and 1.731 million hectares with a total production of about 33.22 and 43.174 million tonnes during 2007-08 and 2010-11, respectively (Anonymous, 2008, 2011). Brinjal is one of the three most important vegetable species cultivated in South Asian region (Bangladesh, India, Nepal, and Sri Lanka) accounting for almost 50% of world's area under its cultivation (Alam *et al.*, 2003). As per FAO (2010) data, China is the top producer (58% of world output) while India ranks second (25%) in brinjal production. In the world, brinjal is cultivated in over 4 million acres (approx. 1.6 million hectares).

In India, it is one of the most common, popular, and principal vegetable crops grown throughout the country, except higher altitudes. This versatile crop is adapted to different agro-climatic regions, and may be cultivated in all seasons (http://dbtbiosafety.nic.in/guidelines/brinjal.pdf). It is grown extensively across 29 states in India. The National Horticulture Board (NHB) of India estimated 12.995 million tones production of brinjal for year 2012-13. However, Haryana state ranks 10th nationally in terms of production (0.3 million tonnes) with its meager 2.54% share in the national production of this crop (APEDA, 2013).

Several biotic and abiotic factors contribute in lowering the yield in brinjal. Among various biotic factors, insect pests are important which greatly affect the quality and productivity of brinjal crop through inflicting a direct damage (Gupta *et al.*, 1987). In the tropics, brinjal production is severely constrained by several insect and mite pests. The major insect pests of brinjal include fruit and shoot borer (BSFR), leafhopper, whitefly, thrips, aphid, spotted beetles, leaf roller, stem borer, blister beetle, red spider mite, etc. (AVRDC, 2009). Arthropod biodiversity in the brinjal field showed that the BSFR was the major and serious insect pest of brinjal crop (Latif *et al.*, 2009, Nair, 1975). It infests both vegetative as well as reproductive stages which cause heavy losses in the yield to a tune of 40 to 80% (AVRDC, 2003). The incidence of this insect pest occurs either sporadically or in outbreak every year in the Indian subcontinent (Dhankar, 1988). Sandanayake and Edirisinghe (1992) reported that the larval feeding in fruit and shoot is mainly responsible for the damage to eggplant crop in Sri Lanka. The reduction in yield of brinjal fruits has been reported as high as 70% (Islam and Karim, 1991 and Dhandapani *et al*., 2003). The BSFR infestation is responsible for both the qualitative and quantitative degradation of fruits round the year, but it attains the most serious stature during monsoon months (Chowdhury and Kashyap, 1992).

The number of eggs laid by BSFR female varies from 80 to 253 which are laid singly on the lower surface of the young leaves, green stems, flower buds, or calyces of the fruits. Eggs hatch in 3 to 6 days, and soon after hatching, young caterpillars bore into tender shoots near the growing point. They soon migrate into flower buds or the fruits. Larvae go through at least five instars. The larval period lasts 12 to 15 days in the summer and up to 22 days in the winter (Atwal, 1976). Mature larvae come out of their feeding tunnels and pupate in tough silken cocoons among the fallen leaves and other plant debris on the soil surface (Fig. 1). The pupal period lasts for 6 to 17 days depending upon temperature. Longevity of adults was 1.5 to 2.4 days for males and 2.0 to 3.9 days for females (Mehto *et al.,* 1981). The life cycle is completed in 20-43 days during the active season. There are five overlapping generations in a year (Thakur *et al.,* 2009).

The larvae of this pest initially feed on the terminal shoots damaging the growing points. Later these larvae bore into fruits and feed inside the contents making fruits unfit for human consumption (Srinivasan, 2008). Such attacks adversely affect not only the quality, but also the yield of the crop causing considerable economic damage every year. The variability in their population and damage can be related to changes in the ambient environment. With a view on the climate change projections for India, an attempt has been made here to study the impact of the likely changes in temperature on the pest complex in relation to BSFR in brinjal crop under Hisar agro-climatic conditions.

MATERIALS AND METHODS

The study on population dynamics of *L. orbonalis* was carried out at the research farm of the Department of Entomology, CCS Haryana Agricultural University (HAU), Hisar on HAU recommended brinjal variety BR-112, a popular variety among farmers of Hisar region, during the summer of 2009-10. In this experiment, 90 experimental plants were planted on 150 m^2 area. No pesticide was used throughout the experiment. Population of BSFR larvae during the experimental period i.e. 38th standard week (second week of September) to 48th standard week (last week of November, 2009) was recorded on these untreated experimental plots (Table 1). The observations on larval population of BSFR were taken regularly at 10 days interval till the completion of this experiment. Population of BSFB larvae was first observed on brinjal shoots in the 41st standard week (first week of October, 2009). As fruit bearing initiated, these larvae were observed migrating to developing fruits. The damaged fruits were harvested and carefully cut opened with a sharp knife to observe the presence of larvae in the fruits. From this data, per cent damage was calculated. These damaged brinjal fruits were kept in laboratory at 27 ± 2ºC and 70% RH to observe the adult moth emergence from the pupae. Weekly meteorological data on temperature and % RH throughout the experimental period was procured from the Meteorological Department, HAU. Correlation was worked out between these two abiotic factors and BSFR pest population. SAS 9.2 software (http://support.sas.com/software/92/index.html) was used to analyse the data between temperature, relative humidity and BSFR population.

RESULTS AND DISCUSSION

The BSFR larvae initially fed on brinjal shoots, and later when plants bear fruits, the larvae prefer to feed on fruits. Initially, the larval population was recorded feeding on shoots up to 41st standard week and thereafter these larvae were observed feeding on fruits. Maximum number of larvae i.e. 10 larvae/90 plants were recorded from shoots as well as fruits in the 39th and 40th standard weeks (third and last week of September, 2009). On an average, 7 larvae/90 plants were observed in the 38th standard week (second week of September, 2009) when the average temperature and % RH were 28.8ºC and 72%, respectively. In the 40th standard week, the larval population increased up to 10 larvae/90 plants when the average temperature was 30.5ºC and average RH was 56%. Interestingly, the average population drastically declined after 41st standard week i.e. from 4 larvae/90 plants to 0.5 larvae/90 plants in the 47th standard week. However, no larva was observed in 48th standard week.

As the temperature declined, the population of BSFR also declined till the end of November, 2009 (Table 1). The meteorological data was correlated with the population of BSFR on brinjal for conducting studies on population dynamics. The larval population are positively correlated with temperature and negatively correlated with % RH (Table 2, Fig. 2).

Table 1: Population of *Leucinodes orbonalis* Guenée larvae on brinjal

Standard weeks	Mean population in shoots and fruits (larvae/90 plants)	Average temperature (ºC)	Average relative humidity (%RH)
38	7.0	28.8	72.0
39	10.0	29.7	45.5
40	10.0	30.5	56.0
41	4.0	25.3	69.0
42	5.0	24.8	55.5
43	3.7	20.9	67.5
44	4.3	18.0	65.5
45	3.3	16.8	61.5
46	1.0	14.0	64.0
47	0.5	10.3	85.5
48	0.0	14.5	71.5

Table 2: Correlation between *Leucinodes orbonalis* Guenée larvae and environmental factors

r values	Population	Temperature	Relative humidity
Population	1.0		
Temperature	0.9	1.0	
Relative humidity	- 0.6	- 0.6	1.0

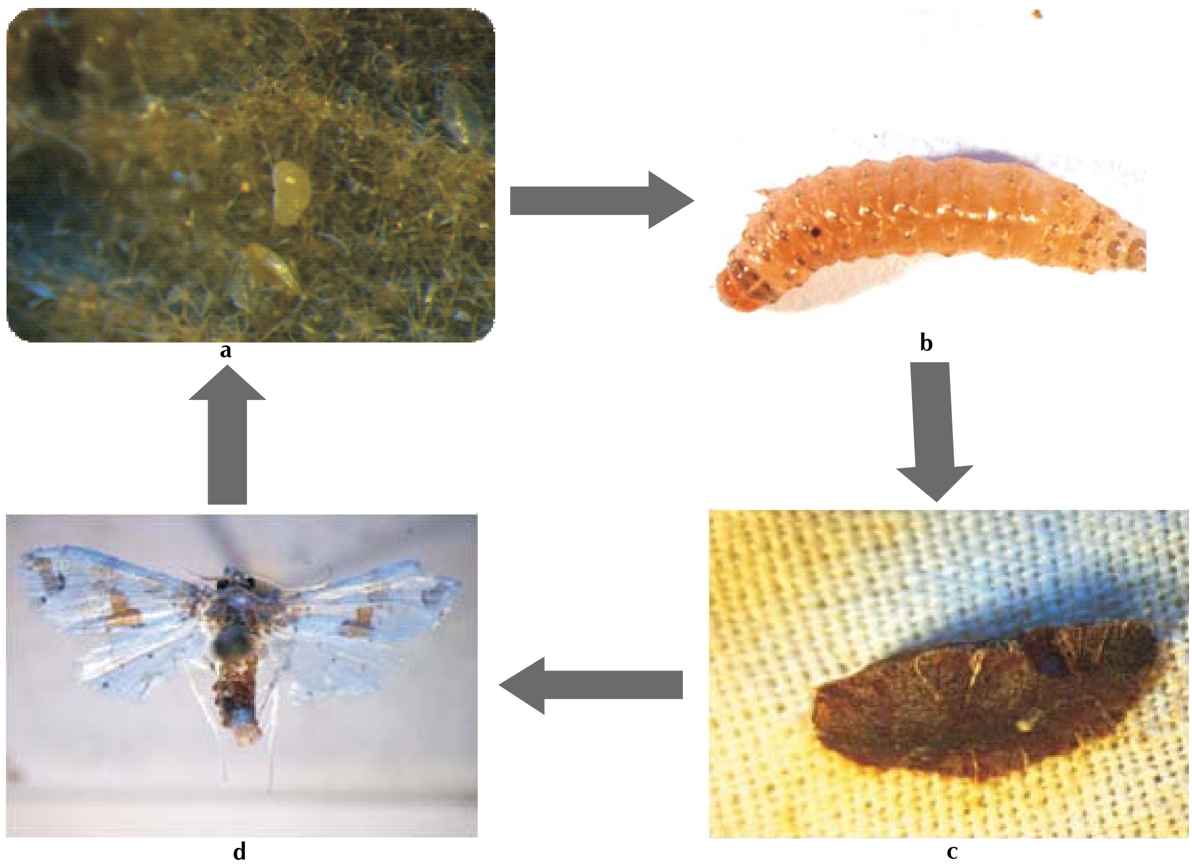

Figure 1: a) eggs, b) larva, c) pupa and d) adult of brinjal shoot and fruit borer (photo: Prabhjot Kaur)

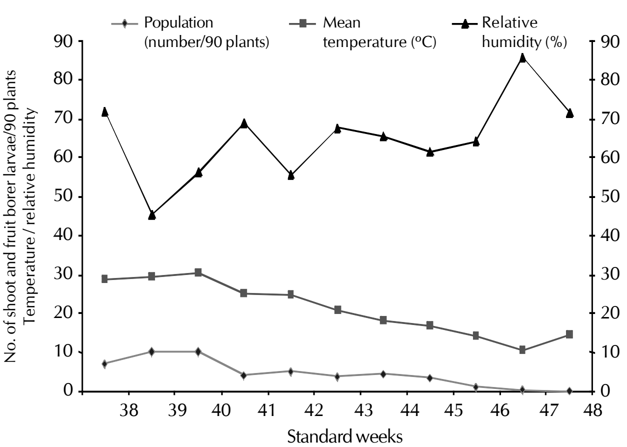

Figure 2: Population dynamics of *Leucinodes orbonalis* Guenée under HAU agroclimatic conditions during *Kharif* 2009

The BSFR population was abundant during monsoon months as reported by Atwal and Verma (1972). The maximum increment in BSFR was observed between temperature ranges of 22 to 35ºC by many researchers. Lal (1975) observed BSFR infestation on brinjal throughout the year except during severe winter months in Kulu region of West Himalaya. Likewise, Mehto *et al*. (1981) too observed BSFR as a pest of brinjal crop round the year. BSFR incidence was observed during *kharif* and summer seasons by Pawar *et al*. (1986). Shukla (1989) observed peak population of BSFR in first week of July and third week of August in Meghalaya. However, Shukla and Khatri (2010) observed the highest BSFR population in the second week of February which lasted till first week of summer in Kanpur region.

Om Parkash (1978) reported that a maximum population (10 larvae/10 fruits) of BSFR on brinjal shoots as well as fruits was observed during the months of July-September when the mean atmospheric temperature was above 30ºC and % RH ranged between 60-70%, respectively. Patel *et al*. (1988) and Dhamdhere *et al*. (1995) found moderate temperature and high humidity favouring the BSFR population build-up during the summer 1987. Many of the earlier workers have also reported the incidence of BSFB throughout the year in different regions of South East Asia (Khan and Al-salem 2007, Mall *et al*., 1992). The findings of current study are in agreement with Rao and Bhavani (2010) who reported the highest damage of 62.83 per cent in November which in turn supported the results of the present study that pest damage was higher in the month of September which is in a similar temperature regimen. Our present studies are in great accordance with Katiyar and Mukharji (1974) who reported the highest damage of 90 per cent in the month of November.

Results of present research study clearly showed that the peak period of incidence of BSFR larvae was in the third and last week of September. However, with the decline in temperature, the population of BSFR larvae also decreased. The data in the Table 1 indicates that mean population of BSFR incidence (number of larvae/90 plants) of brinjal had a positive correlation with maximum and minimum temperatures under Hisar conditions. Maximum %RH had a negative correlation with BSFR infestation. Singh and Singh (2002) reported that the seventh generation of BSFR (December-March) was the longest with lowest fecundity and larval survival while the fourth generation (August-September) was the shortest due to weather conditions. These findings are in accordance with the current findings. Mathur *et al.,* (2012) revealed a significant correlation with maximum and minimum temperature and negative correlation with %RH. These findings are also in favour of present findings. The BSFR infestation was 73.33% on the top shoots of brinjal at the beginning of September and infestation peaked (86.66%) by the third week of September, with an intensity of 2.90 caterpillars per plant (Singh *et al.,* 2000). Earlier reports also suggest that maximum and minimum temperature and incidence of BSFR showed a positive correlation (Prasada and Logiswaran, 1997). The present findings are in agreement with the reports of Rashid *et al*. (2013) wherein the increase in temperature was significantly conducive for BSFR multiplication, but % RH has shown negative response on this pest intensity. Singh and Singh (2003) found that the highest levels of fecundity of BSFR occurred when the average maximum temperature was more than 27ºC, the average minimum temperature was more than 17ºC and the average relative humidity was more than 85%.

After analyzing the data using SAS 9.2 program, the Linear Regression Model results have revealed that the average temperature (as observed on standard weekly basis) was found to be significant to the BSFB populations, while the % RH find not significant. Therefore, the larval populations are positively correlated with temperature and negatively correlated with % RH. As the temperature declined, the population of BSFR also declined till the end of November, 2009.

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