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Population dynamics of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenée) during the cropping season and its correlation with weather parameters

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Abstract
This experiment was carried out in *kharif* 2017 at experimental Pusa farm of Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar which is situated on the south and west bank of the river Budhi Gandak at an altitude of 52.92 m above mean sea level and lies at $25^{0}98^{\text{‟}}$ North latitude and $85^{0}64^{\text{‟}}$ East longitude. The pest infested the crop after four weeks of transplant, that is the stage of initiation of flowers and population of *L. orbonalis* was observed in the 38th standard week i.e. from 5th week after transplanting of experiment and it was continuously increased up to 43rd standard week i.e. 10th week after transplanting (19.24%), after that the population stabilized up to 48th standard week and their after showed decreasing trend. It could be further inferred that the pest population in the beginning was low (2.73%), which gradually increased and reached at its peak (19.36%) in 47th standard week. The maximum number of per cent infestation of brinjal shoot and fruit borer (19.36%) was recorded during 47th standard week. On other hand minimum population of brinjal shoot and fruit borer (2.73%) was recorded during 38th standard week that was initial infestation.

Keywords: shoot and fruit borer, brinjal

Introduction
Vegetable farming have an important place in Indian agriculture, due to its nutritional, medicinal and commercial value and occupy 2 to 5 per cent of the total cropping area in the country, India produces 14 per cent (146.55 million tonnes) of world‟s vegetables from 15 per cent (8.5 million hectares) of world area under vegetables and now rank second in world vegetable production just after China. Productivity of vegetables in India (17.3 t/ha) is slightly less than the world average productivity (18.8 t/ha). Potato (28.9%), tomato (11.3%), onion (10.3%) and brinjal (8.1%) are the four major vegetables contributing 58.6 percent of total vegetable production in our country [29]. Among the different vegetables, brinjal/ eggplant/ aubergine (*Solanum melongena* L.) is one of the most important solanaceous annual vegetable crops and is also known as *baigan* or *bhanta*, which is available throughout the year for consumption in the market. In India, brinjal is grown extensively in Bihar, Orissa, Karnataka, Andhra Pradesh, Maharashtra, West Bengal, Uttar Pradesh and states with matching climatic conditions in the tropics and subtropics. The area, production and productivity of brinjal are: India- 7.1 Lakh ha, 135.58 Lakh MT, 19.1 /MT/ha; Bihar – 57500 ha, 12.40 Lakh MT, 21.6 /MT [24]. It is native of India and highly cosmopolitan and popular vegetable grown as a poor man‟s crop in the country. It is although popular in throughout the country but in eastern states of India; it is one of the preferred dishes. It is the most consumed and most sprayed (plant protection measures) vegetable in India, making it one of the main sources of cash for farmers [8]. It is a very popular vegetable in many parts of the world, particularly in the warm parts of southern Europe, the Middle East, and Asia. In 2013, global production of brinjal was 49.4 million tonnes, with 57 per cent of output coming from China followed by India (27%), Iran, Egypt and Turkey were also major producers which, combined with other Asian countries, constitute 94 per cent of world production. More than 18 lakh hectares area are devoted to the brinjal cultivation in the world [2].
Brinjal is an economically important commercial crop and reported to be infested by more than 36 pests from the time of its planting to harvest [23]. Among the insect pests shoot and fruit

borer (*Leucinodes orbonalis*), hadda beetle (*Epilachna viginitiopunctata*), jassid (*Amrasca biguttula biguttula*), whitefly (*Bemisia tabaci*) are important one. Non-insect pests like red spider mite (*Tetranychus macferlane*) [3] is also associated with the crop. Among them, brinjal shoot and fruit borer, (*Leucinodes orbonalis* Guenee, is considered to be the key pest and it has become a very serious production constraint in brinjal growing countries [1].

Brinjal shoot and fruit borer (BSFB), *Leucinodes orbonalis* Guenée (Lepidoptera: Crambidae) is the most destructive pest of brinjal. The damage by this insect starts soon after transplanting of the seedlings and continues till harvests of fruits. Eggs are laid singly on ventral surface of leaves, shoots, and flower-buds and occasionally on fruits and calyx. After hatching, the tiny larvae bore in the growing tips of young shoot during their early growth stage [11]. In young plants, the appearance of wilted drooping shoots is the typical damage symptom of this pest; these affected shoots ultimately wither and die away. During flowering and fruiting stage, the larvae prefer flower buds and young fruits and bore into the young fruits. Initially the larva makes a very small hole around the calyx, and goes inside the fruit. Thereafter, it completes its larval stage within the growing fruit and the mature larva comes out from the fruit for pupation. In Bihar, it causes extensive damage both at vegetative as well as reproductive stages of the crop [14]. Crop losses due to this borer in various parts of India in different season had been reported to the tune of 20-80 per cent [21]; 85–90 per cent [17] and 70-92 per cent [7]. The larvae bore into fruits and feed inside, making fruits unfit for human consumption [26] and simultaneously greatly reduces commercial value. [12] reported that a single larva is enough to damage 4-6 healthy fruits.

Materials and Methods

Layout and design of experiment

To study the seasonal incidence of *L. orbonalis* Guenée on brinjal in relation to weather parameters, brinjal variety "Pant Rituraj" was transplanted on 22th august 2017 in the plots size of 5 x 5 m^2 keeping row to row and plant to plant distance of 75 cm apart, on ridges to avoid losses caused by water logging during heavy rainfall.

Observations

To study the population dynamics of *L. orbonalis* Guenée, ten randomly selected plants were tagged for recording regular observations.

Observations on Shoot infestation

The observations recorded, total number of secondary shoots and number of infested shoot, followed by total number of harvested fruits and number of infested harvested fruits and by this way we had calculated per cent fruit infested and per cent shoot infested using following formula-

$$\text{Per cent Shoot infestation} = \frac{\text{Number of infested shoots}}{\text{Total number of secondary shoots}} \times 100$$

To avoid repetition in observations, the infected shoot are clipped off at each observation.

Observations on fruits infestation

Fruit picking was started when brinjal fruits attained full size and still remain tender, bright coloured with glossy appearance. It was done with the help of sharp knife at an interval of a week. The fruits were harvested at weekly interval at fruiting stages and after that total number of fruits and number of infested fruits per plant were counted separately and per cent fruit infestation were determined and yield loss were accessed accordingly in term of per cent fruit loss (qualitative) and yield loss in terms weight (quantitative) and per cent weight loss were calculated by using following formula and loss in weight per hundred gram produce were calculated as per cent weight (quantitative) loss.

$$\text{Fruit weight loss (qualitative)}: = \frac{\text{Weight of random five healthy fruit} - \text{Weight of five random infested fruit}}{5}$$

The meteorological data were obtained from Department of Agronomy, meteorological section of Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar and population of *L. orbonalis* Guenée larval population (infested as fruit as well as shoot infestation) were correlated with weather parameters of the cropping season to get their impact on population development.

Results and Discussion

The data pertaining to the level of infestation in terms of per cent infestation have been summarized in Table-1. It is apparent from the observed data, this pest infested the crop after four weeks of transplanting, i.e. the stage of flowering and the population of *L. orbonalis* was observed in the 38th standard week *i.e.* from 5th week after transplanting of experiments and it continuously increased up to 43rd standard week *i.e.* 10th week after transplanting (19.24%). After that the population remained stabilized up to 48th standard week and there after showed decreasing trends. It could be further inferred that the pest population in the beginning was low (2.73%), which gradually increased and reached at its peak (19.36%) on 47th standard week. There after its population started declining slowly in consequent observations (18.08 to 7.96%) *i.e.* after 48th to 52th standard week. The maximum populations (19.36%) were observed in 47th standard week. As far as the effect of weather parameters is concerned, the maximum number of per cent infestation of brinjal shoot and fruit borer (19.36%) was recorded during 47th standard week, when corresponding weather parameter *viz.* maximum, minimum temperature (0^0C), relative humidity (%) at 07 and 14 hours, rainfall (mm), wind velocity (km/hr) and sunshine (hours) were 27.8, 12.4, 85, 61, 0, 2.5, and 5.3, respectively. On the other hand minimum population of brinjal shoot and fruit borer (2.73%) was recorded during 38th standard week that was initial infestation, when the weather parameters were 33.5, 26.1, 88, 70, 30, 6, and 5.2, respectively.

From the experimental findings, it was quite clear that the population of brinjal shoot and fruit borer (both on shoots and fruits) gradually increased after 38th standard week (5th week after planting) and reached its peak during 44th to 48th standard week (19.24 to 18.08% respectively), thereafter was observed a sudden drop in population at 49th standard week (15.39%) and onward (7.96%).

In the present investigation recorded less level of infestation in comparison to the normal infestation level in the region. While the infestation level was high and temperature and humidity were fair. After starting autumn and winter (decrease in temperature and humidity) the population of the *Leucinodes orbonalis* was decreased. These findings are similar like [27, 6] also recorded, the population adversely affected by severe cold. The initial infestation of *Leucinodes*

orbonalis were recorded in the 5th week after transplanting that‟s also as similar findings observed by [20] they also observed the initial infestation were on shoots only while gradually the infestation shifted towards on fruits when plants were started fruiting, this also match with our findings. [22] also observed a decrease in population of *Leucinodes orbonalis* during winter months while gradually regain after rise in temperature. The infestation level was on its peak in the early November during the course of investigations, the similar findings observed by [20] also.

The level of infestation were quite low during the course of investigations as observed in other plots at first look in the region, this may be attributed to site of experimentation because the experimental plot having negligible plants of brinjal in the nearby plots of the experimental farm. The different level of infestations observed by several workers is quite high and the pest creates havoc among the growers about the pest. The level of shoot infestations were recorded 6.56 to 20.76 during the present investigation *i.e.* also similar with the finding of [9] where they recorded the shoot infestation range 7.56 to 23.55. [28] Observed the maximum extent of damage occurred at minimum atmospheric temperature and humidity 19.4 ^{0}C and 61%, the similar findings were recorded in the present investigations where stabilized population at 44th standard week with minimum average temperature 19.5 ^{0}C and relative humidity 60% (Table-1).

The impacts of abiotic factors on the population build up of *Leucinodes orbonalis* are shown in Table-2. The data indicate that the minimum temperature, relative humidity, rainfall, wind velocity and sunshine hours have great impact on the population built up of *Leucinodes orbonalis* that is having highly significant relation, which shows that a decrease in temperature greatly reduce the population of *Leucinodes orbonalis*. While maximum temperature and relative humidity in morning hours have non-significant impact on *Leucinodes orbonalis* population.

[15] recorded the infestation by the pest was significantly affected with temperature than other environmental factors and similar findings were observed here also, when the minimum was going below 12 ^{0}C, the gradual decrease in population were recorded and when the temperature reach below 10 ^{0}C, sudden decrease in infestations recorded.

[18] reported the incidence of shoot and fruit borer lasted for 15 weeks, started from 4th week after transplanting similarly in our investigation the infestation were started after 4th week of transplanting and present on the crop for 15 weeks. In the present investigation the initial infestation were started in the early September and reached at its peak in the last October then the population was stabilized and similar findings were also recorded by [4, 25, 5, 10, 13]. In the present investigations the average losses caused by brinjal shoot and fruit borer were 19.36 to 29.52 per cent, similarly [10] also recorded an average loss caused by brinjal shoot and fruit borer were 25.33 per cent, while [16] recorded an average yield loss of 23.49 per cent. Although the crop loss caused by the pest were varying 12.12 to 9.52 per cent on a weight basis and 13.28 to 88.89 per cent on number basis [19].

[30] Reported a maximum loss in brinjal in *kharif* up to 76.65 per cent while in *rabi* 52.16 per cent in local “Kachbachia‟ variety. These variations in the infestation may be due to physiographic situation of experimental area, experimental season and prevailing abiotic factors. The outcome of two experiments may or may not similar due to different concerned factors because the population of any organism may be affected by several factors that may not be similar.

Table 1: Population dynamics of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenée) on brinjal cv. Pant Rituraj during the cropping season and its correlation with weather parameters

SMW	% pest infestation	Temperature (^{0}C)		RH (%)		Rainfall	Wind velocity	Sunshine
		Max.	Min.	7 AM	2 PM	(mm)	(km/hr)	(hr)
34	0.00	33.2	26.8	87	71	41.8	4.7	6.5
35	0.00	32.8	26.5	88	76	2.6	5.5	5.9
36	0.00	33.9	26.3	88	65	11.2	3.3	6
37	0.00	34	27	91	71	2.6	3.4	4.9
38	2.73	33.5	26.1	88	70	30	6	5.2
39	6.23	34.3	25.8	88	62	0	3.1	5.4
40	10.17	33.2	25	87	70	0	3.6	6.9
41	15.09	33.1	25	89	69	3.5	4.2	8.1
42	16.93	33.4	22.8	88	63	0	3.5	8.0
43	19.30	31.5	20.8	90	66	0	2.8	7.2
44	19.24	29.8	19.5	86	60	0	2.4	8.9
45	17.50	30.2	17.3	87	56	0	1.5	8.6
46	18.65	29.6	16.7	87	56	0	2	6.5
47	19.36	27.8	12.4	85	61	0	2.5	5.3
48	18.08	26.1	10.6	91	64	0	1.2	1.8
49	15.39	26.5	10.5	94	64	0	1.2	1.0
50	13.11	27.1	12.5	92	64	0	2.3	1.8
51	10.85	22.6	11.8	94	71	0	2.2	3.4
52	7.96	20.3	9.3	95	77	0	2.3	1.1

*SMW-Standard Meteorological Week.

Table 2: Correlation co-efficient of abiotic factors with brinjal shoot and fruit borer during *Kharif* 2017:

Sl. No.	Abiotic factor	Correlation (r)
1	Maximum temperature	NS
		-0.361
2	Minimum temperature	**
		-0.590
3	Relative humidity (7 hrs)	NS
		-0.062
4	Relative humidity (14 hrs)	**
		-0.654
5	Rainfall (mm)	**
		-0.569
6	Wind velocity (km/hr)	**
		-0.660
7	Sunshine (hr)	**
		-0.846
Coefficient of determination (R^2) = 0.44 ** Level of significance: P = 0.01		

Conclusion

The experimental findings clearly reveals that the pest population in the beginning was low (2.73%), which gradually increased and reached at its peak (19.36%) in 47th standard week. The impact of abiotic factors on the population buildup of *Leucinodes orbonalis* revealed that the minimum temperature, relative humidity, rainfall, wind velocity and sunshine hours have great impact on the population built up of *Leucinodes orbonalis*, 54that is having highly significant relation, which show that decrease in temperature greatly reduce the population of *Leucinodes orbonalis*. While maximum temperature and relative humidity in morning hours have non-significant impact on *Leucinodes orbonalis* population.

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