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Impact of weather on population dynamics and infestation of *Leucinodes orbonalis* Guenee on brinjal

Ejazul Haq [a*] and Parvez Qamar Rizvi [a]

[a] *Department of Plant Protection, Faculty of Agricultural Sciences, Aligarh Muslim University, Aligarh-202002, India.*

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The purpose of this study was to determine the effect of weather parameters on the infestations of shoot and fruit caused by brinjal shoot and fruit borer (*Leucinodes orbonalis*) (Lepidoptera; Pyralidae) during Kharif and Rabi seasons of two consecutive years. The findings showed that the shoot infestation began (5.35%) in 1st week of January and severed (30.85%) in 3rd week of February and 1st week of March in the first and second years. The shoot infestation was associated positively (r=0.267) with temperature but negatively with relative humidity and rainfall (r=-0.182 and -0.235). The fruit infestation (26.57% and 21.74%) began in the 1st week of February and gradually peaked (52.69 and 46.36%) in the 1st week of March. However, it was associated negatively with relative humidity (r=-0.773 and 0.747) and rainfall (r=-0.204 and -0.202) while positively with temperature during the rabi season of the first year. The same patterns of infestations were recorded in the next year. Compared to the Kharif seasons, shoot infestation

**Corresponding author: E-mail: ejazulhaq1297@gmail.com;*

started (7.65%) in 1st week of July and the highest (31.21%) in 3rd week of August. Additionally, it was associated negatively with temperature (r=-0.235) while positively with relative humidity and rainfall (r=0.060 and 0.677). The infestation of the fruit started (27.35 and 21.25%) in 1st week of August and steadily increased, reaching to peak (53.26 and 47.22%) in 1st week of September. Moreover, it was associated negatively with temperature (r=-0.500 and -0483) and positively with relative humidity (r=0.426 and 0.443). However, a negative association (r=-0.187 and -0.180) was found with rainfall. While in the second year, the same infestation patterns were recorded as the previous year, except rainfall was positively (r=0.0283 and 0.287) associated with fruit infestation. In conclusion, the weather affects the BSFB infestation significantly or non-significantly. This finding could be helpful for farmers in planning their cultivation practices for brinjal and pest management strategies to reduce the infestation caused by BSFB.

Keywords: Brinjal; fruit and shoot borer; seasonal incidence; abiotic factor.

1. INTRODUCTION

The brinjal is a solanaceous crop, also recognized by eggplant and aubergine. It originated in tropical Asia, where it has been used both as food and medicine for a long time. On the other hand, most people thought that the brinjal was first cultivated in India [1,2] or Indo-Burma [3]. There is no evidence that brinjal farming moved from one place to another. However, written records from India and China only go back 2,000 years [4,5]. Today, many countries, especially in Asia, Africa, and the Americas, grow and consume brinjal [3]. Brinjal is a highly productive vegetable crop frequently grown by low-income farmers [6]. It is a rich source of minerals, vitamins, and fiber [7]. Additionally, it has an antioxidant that protects the body from free radicals, which may injure cells and start diseases like cancer and heart disease. India is one of the largest producers of brinjal worldwide, cultivating it across an area of 0.71 million hectares and yielding 13.56 million tonnes [8]. The leading producing states for brinjal in India include Andhra Pradesh, Karnataka, West Bengal, Tamil Nadu, Maharashtra, Odisha, Uttar Pradesh, Bihar, and Rajasthan. Insect pests are critical in determining agricultural yield, even if numerous other factors might affect it [9]. The brinjal crop is vulnerable to insect pests such as the white-spotted spider mite, flea beetles, aphids, whiteflies, leaf miners, thrips, and the brinjal shoot and fruit borer. As they harm the crop year-round, even minor pests like leaf rollers and hairy caterpillars are considered the principal restrictions [10]. Reports show that major pests attacking the brinjal crop reduce 70–92% of yield [11]. The most damaging of these insects is the brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee (Lepidoptera: Pyralidae) [12]. With their awful shoots and fruit borer, these pests can cause significant crop losses. It damages tender shoots and fruits, reducing yield by up to 90% in different country locations [13,14]. To manage the population of pests and raise the quality of brinjal crops, it is crucial to understand the seasonal activity of the pests and the environmental factors affecting their population dynamics. This study focuses on *L. orbonalis* Guen, a harmful pests that prefer brinjal and aims to determine its seasonal incidence and the influence of weather variables on population build-up.

2. MATERIALS AND METHODS

The study aimed to investigate how weather parameters influenced the seasonal incidence of *L. orbonalis* Guen, during crop seasons. A desi variety of brinjal was grown in a 5 x 5 m^2 plot at the Department of Plant Protection, Faculty of Agricultural Sciences, AMU, Aligarh, India, in the Rabi and Kharif seasons of 2020–2021 to 2021–2022, with 75 cm between rows and 75 cm between plants. The damage caused by BSFB to the shoots and fruits of the brinjal plants was recorded weekly by visual counting from the transplanting until the final harvest or last crop picking. Observations were statistically correlated with meteorological conditions. The infested fruits were counted and weighed, and the percentage of infested fruits was recorded at each picking on tagged plants. By comparing the infestation of shoot and fruit data with the weather conditions obtained from the Physics Department of Aligarh Muslim University at Aligarh and using standard statistical techniques, the research aimed to determine the impact of various weather parameters on BSFB infestation in the brinjal crop.

3. RESULTS

3.1 Seasonal Incidence and Weather's Impact during Rabi Seasons

The results revealed that the shoot infestations began during 1st week of January (5.35%) and increased gradually until reaching a maximum of 30.85% during 1st week of March (8th SMW). The mean temperature and relative humidity were 21.40°C and 62.07% during this time (Table 1). Similarly, in the second year, the infestation of shoots initiated during early January (5.22%) gradually rose to a maximum of 30.11% by 1st week of March (10th SMW). The temperature ranged from 21.30-23.80°C, and the relative humidity was 62.86% (Table 2). However, the shoot damage Positively associated with temperature (r=0.267) but negatively associated with relative humidity and rainfall (r=-0.182 and -0.167) in first year rabi season (Table 3). During the second year, the shoot infestation was associated positively with temperature (r=0.323) but negatively with relative humidity and rainfall (r=-0.235 and -0.012) (Table 3). The information given in Table 1, the infestation of fruit began in 1st week of February with a rate of 26.57% in number and 21.74% in weight basis. It gradually rose and peaked in 1st week of March (10th SMW), with a rate of 52.69% in number and 46.36% in weight basis. The average temperature was 25.05°C with 55.43% relative humidity during this period. It decreased and continued until the 4th week of April (17th SMW). During the following year, 2021-2022, the results revealed that the fruit infestation was initiated in 1st week of February, with a rate of 27.50% in number and 22.41% in weight. The infestation gradually increased over time and peaked in 1st week of March (10th SMW), with a rate of 48.22% in number and 43.36% in weight. Afterward, the infestation rate declined until the 4th week of April (17th SMW). At that time, the temperature ranged from 21.30 to 23.80°C and the relative humidity was 62.86%. However, the fruit damage was associated negatively with relative humidity (r=-0691 and -0.663) and rainfall (r=-0.204 and -0.202) but positively with temperature (r=0.773 and 0.747) in the first year of rabi season in both number and weight basis (Table 4&5). Furthermore, the fruit infestation was associated positively with temperature (r=0.699 and 0.666) and negatively with relative humidity (r=-0.638 and -0.603) and rainfall (r=-0.182 and -0.191) in both number and weight basis (Table 4&5).

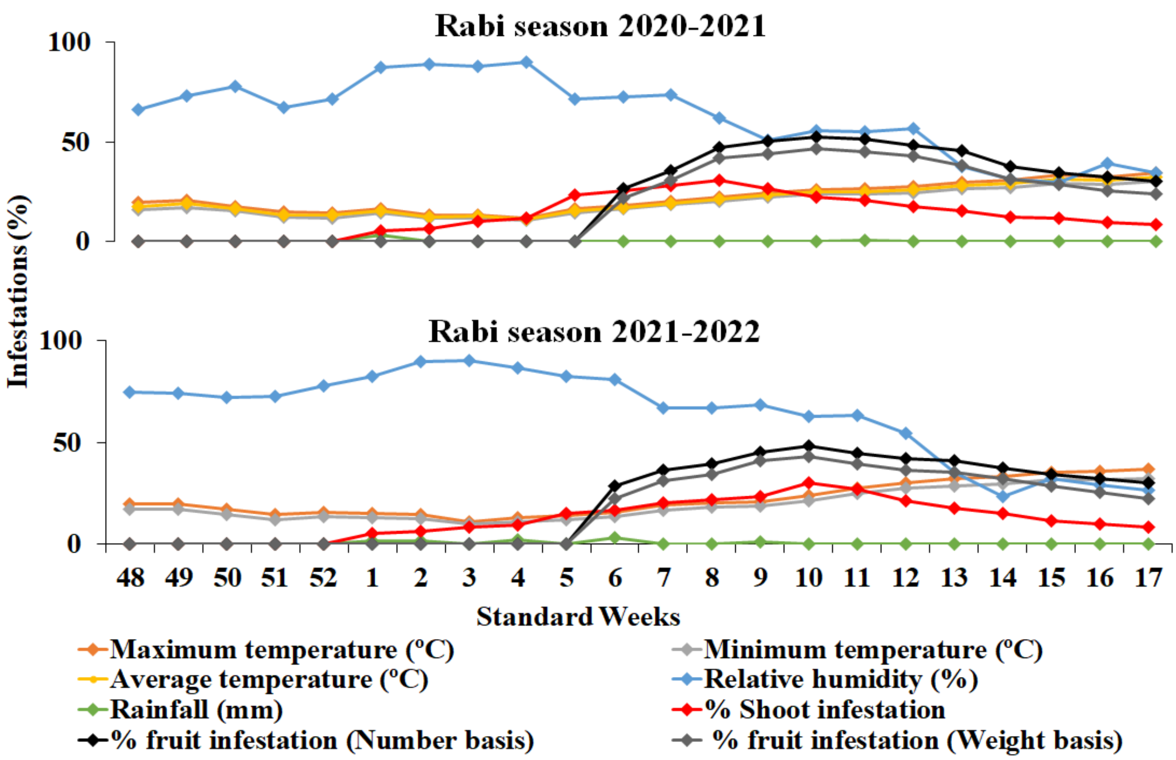

Fig. 1. Shoot and fruit infestations during the Rabi seasons

Table 1. Seasonal incidence of BSFB on shoots and fruits of brinjal during rabi and kharif seasons 2020-2021

Standard Weeks (SW)	Maximum temperature (ºC)	Minimum temperature (ºC)	Mean temperature (ºC)	Relative humidity (%)	Rainfall (mm)	% Shoot infestation	% fruit infestation (number basis)	% fruit infestation (weight basis)
Rabi season								
48	19.64	15.71	17.68	66.00	0.00	0.00	0.00	0.00
49	20.84	17.19	19.01	73.21	0.00	0.00	0.00	0.00
50	17.41	15.30	16.36	77.57	0.00	0.00	0.00	0.00
51	14.66	12.15	13.40	67.29	0.00	0.00	0.00	0.00
52	14.36	11.89	13.13	71.63	0.00	0.00	0.00	0.00
1	16.40	14.11	15.26	87.43	3.44	5.22	0.00	0.00
2	13.19	11.61	12.40	88.71	0.24	6.34	0.00	0.00
3	13.51	11.64	12.58	87.93	0.00	10.23	0.00	0.00
4	11.84	10.49	11.16	89.79	0.00	11.67	0.00	0.00
5	16.41	14.59	15.50	71.50	0.00	23.14	0.00	0.00
6	18.21	16.24	17.23	72.43	0.04	25.47	26.57	21.74
7	20.21	18.41	19.31	73.64	0.00	28.31	35.49	30.65
8	22.39	20.41	21.40	62.07	0.00	30.85	47.32	41.65
9	24.59	22.47	23.53	51.00	0.00	26.31	50.17	44.21
10	26.16	23.94	25.05	55.43	0.00	22.41	52.69	46.36
11	26.33	23.86	25.09	55.29	0.36	20.82	51.41	45.21
12	27.44	24.59	26.01	56.57	0.00	17.45	48.25	42.75
13	29.51	26.34	27.93	37.79	0.00	15.22	45.36	38.32
14	30.71	27.07	28.89	31.50	0.00	12.36	37.69	31.25
15	33.61	29.06	31.34	29.43	0.00	11.69	34.24	28.36
16	32.50	28.57	30.54	39.14	0.30	9.72	32.33	25.31
17	34.23	30.03	32.13	34.29	0.00	8.32	30.26	23.66
Kharif season								
23	36.20	32.80	34.50	48.29	0.00	0.00	0.00	0.00
24	32.69	29.60	31.14	62.79	1.06	0.00	0.00	0.00
25	32.61	29.80	31.21	67.21	1.37	0.00	0.00	0.00
26	36.13	32.94	34.54	51.57	0.00	0.00	0.00	0.00
27	36.94	33.80	35.37	47.14	0.00	7.65	0.00	0.00
28	33.80	30.39	32.09	69.50	0.66	8.72	0.00	0.00

Standard Weeks (SW)	Maximum temperature (ºC)	Minimum temperature (ºC)	Mean temperature (ºC)	Relative humidity (%)	Rainfall (mm)	% Shoot infestation	% fruit infestation (number basis)	% fruit infestation (weight basis)
29	30.70	27.90	29.30	83.86	14.04	9.63	0.00	0.00
30	31.37	28.61	29.99	82.36	6.43	18.64	0.00	0.00
31	30.20	27.21	28.71	86.43	3.90	19.47	0.00	0.00
32	32.00	28.31	30.16	77.43	0.33	24.66	27.45	21.63
33	33.67	31.31	32.49	65.43	0.00	29.63	35.62	29.75
34	31.46	28.69	30.07	79.64	3.34	31.21	38.65	33.17
35	30.27	27.59	28.93	84.50	1.54	24.36	45.52	40.63
36	30.99	27.99	29.49	84.29	3.91	23.41	53.26	47.22
37	29.79	26.50	28.14	84.71	2.17	21.47	52.78	46.32
38	29.31	26.54	27.93	84.36	1.86	20.33	50.36	45.71
39	30.47	27.89	29.18	80.00	0.01	19.64	49.87	44.23
40	31.31	29.03	30.17	71.00	0.53	18.75	48.55	41.36
41	30.79	27.70	29.24	64.36	0.00	14.65	39.64	33.32
42	27.06	24.89	25.97	70.07	4.86	11.58	35.48	29.68
43	25.63	23.41	24.52	63.14	3.61	10.47	33.12	27.23
44	24.37	21.47	22.92	61.79	0.00	8.32	31.78	25.37

Table 2. Seasonal incidence of BSFB on shoots and fruits of brinjal during rabi and kharif seasons 2021-2022

Standard Weeks (SW)	Maximum Temperature (ºC)	Minimum Temperature (ºC)	Mean temperature (ºC)	Relative Humidity (%)	Rainfall (mm)	% Shoot infestation	% fruit infestation (Number basis)	% fruit infestation (Weight basis)
Rabi season								
48	20.01	17.49	18.75	74.71	0.00	0.00	0.00	0.00
49	20.10	17.46	18.78	74.21	0.00	0.00	0.00	0.00
50	17.29	14.90	16.09	72.00	0.00	0.00	0.00	0.00
51	14.57	12.09	13.33	72.86	0.00	0.00	0.00	0.00
52	15.76	13.79	14.78	77.81	0.14	0.00	0.00	0.00
1	15.40	13.01	14.21	82.71	1.67	5.22	0.00	0.00
2	14.60	12.80	13.70	89.86	1.87	6.34	0.00	0.00
3	11.26	9.91	10.59	90.14	0.00	8.32	0.00	0.00
4	12.99	11.30	12.14	86.79	2.24	9.63	0.00	0.00
5	14.04	12.00	13.02	82.50	0.18	15.36	0.00	0.00

6	15.87	13.51	14.69	81.21	3.48	16.58	28.64	22.41
7	19.13	16.64	17.89	66.79	0.00	20.65	36.33	31.47
8	20.57	18.30	19.44	66.79	0.00	21.87	39.52	34.26
9	21.09	18.60	19.84	68.79	1.10	23.65	45.31	41.21
10	23.80	21.30	22.55	62.86	0.00	30.11	48.22	43.36
11	27.73	25.16	26.44	63.36	0.00	27.36	44.58	39.45
12	30.33	27.74	29.04	54.50	0.00	21.57	42.31	36.47
13	32.09	28.70	30.39	35.64	0.00	17.69	41.11	35.47
14	33.20	29.54	31.37	23.29	0.00	15.45	37.45	32.22
15	35.64	31.56	33.60	32.21	0.00	11.54	34.65	28.64
16	35.96	31.84	33.90	29.14	0.00	9.89	32.22	25.36
17	36.93	32.14	34.54	26.79	0.00	8.37	30.36	22.31
Kharif season								
23	39.24	35.66	37.45	27.29	0.00	0.00	0.00	0.00
24	37.44	36.73	37.09	43.43	0.10	0.00	0.00	0.00
25	32.63	30.59	31.61	61.93	2.16	0.00	0.00	0.00
26	34.09	32.14	33.11	63.50	0.77	0.00	0.00	0.00
27	34.34	32.07	33.21	69.29	0.91	7.21	0.00	0.00
28	34.73	32.81	33.77	61.86	0.00	9.33	0.00	0.00
29	33.03	30.41	31.72	72.57	2.39	12.47	0.00	0.00
30	30.79	29.16	29.97	77.93	3.43	13.66	0.00	0.00
31	30.81	28.91	29.86	79.93	1.83	15.63	0.00	0.00
32	31.14	29.60	30.37	75.29	1.23	23.31	27.12	21.25
33	30.96	29.13	30.04	74.93	1.44	24.65	34.62	28.74
34	30.93	29.29	30.11	74.21	0.53	25.87	36.37	31.55
35	32.36	29.64	31.00	74.21	2.19	31.49	45.10	40.21
36	33.51	31.36	32.44	60.07	0.00	28.54	53.11	47.05
37	30.07	28.10	29.09	77.93	3.24	23.32	52.09	46.11
38	27.64	25.79	26.71	89.07	24.47	18.65	48.63	43.36
39	29.24	27.09	28.16	79.00	0.43	17.42	46.85	41.21
40	28.86	26.99	27.92	75.14	0.07	16.33	41.35	35.41
41	24.81	23.54	24.18	88.07	16.99	13.25	37.61	30.21
42	28.00	24.97	26.49	65.36	0.00	10.47	33.69	27.31
43	26.26	23.37	24.81	57.36	0.00	8.65	32.55	26.31
44	25.79	23.27	24.53	69.71	0.00	7.32	30.26	24.15

3.2 Seasonal Incidence and Influence of Weather during Kharif Seasons

The results revealed that the BSFB on the shoot was initiated during 1st week of July (7.65%) and regularly increased until reaching its peak of 31.21% during 3rd week of August (34th SMW). At that time, the average temperature and relative humidity were 30.07°C and 79.64% (Table 1). Similarly, the recorded data in Table 2 indicates the shoot infestation began in 1st week of July (7.21%) and steadily grew until its highest at 31.49% in 3rd week of August (34th SMW). The average temperature and humidity throughout this period were 31°C and 74.21%, respectively. The shoot damage was associated negatively with temperature (r=-0.232) and positively with relative humidity and rainfall (r=0.677 and 0.060) during the first year kharif season (Table 3). Additionally, it was associated negatively with temperature (r =-0.285) but positively with relative humidity and rainfall (r=0.565 and 0.128) during the second year (Table 3). The fruit infestation was set in 1st week of August, with a rate of 27.45 % in number and 21.63% in weight basis. It was regularly raised and highest in 1st week of September (36th SMW), with a rate of 53.26% in number and 47.22% in weight basis. The mean temperature was 29.49°C during this period with 84.29% relative humidity (Table 2). It began to decrease and continued until 1st week of November. Similarly, in the second year, the infestation set on fruits in 1st week of August (32nd SMW), with a rate of 27.12% in number and 21.25% in weight basis. Over time, the infestation raised gradually and peaked in 1st week of September (37th SMW), with a rate of 53.11% in number and 47.05% in weight basis. The temperature ranged from 31.36 to 33.51°C, while the relative humidity was 60.07%. Subsequently, the infestation rate decreased and continued until 1st week of November (44th SMW). However, the fruit damage was associated negatively with temperature (r=-0.500 and r=-0.483) and rainfall (r=-0.187 and -0.180) but positively (r=0.426 and 0.443) with relative humidity on both number and weight basis in the first year (Table 4&5). Moreover, it was observed that the fruit damage exhibited a negative association with temperature (r=-0.591 and -0.560) and a positive association with relative humidity (r=0.441 and 0.438) and rainfall (r=0.283 and 0.287) on both a number and weight basis during the next year (Table 4&5).

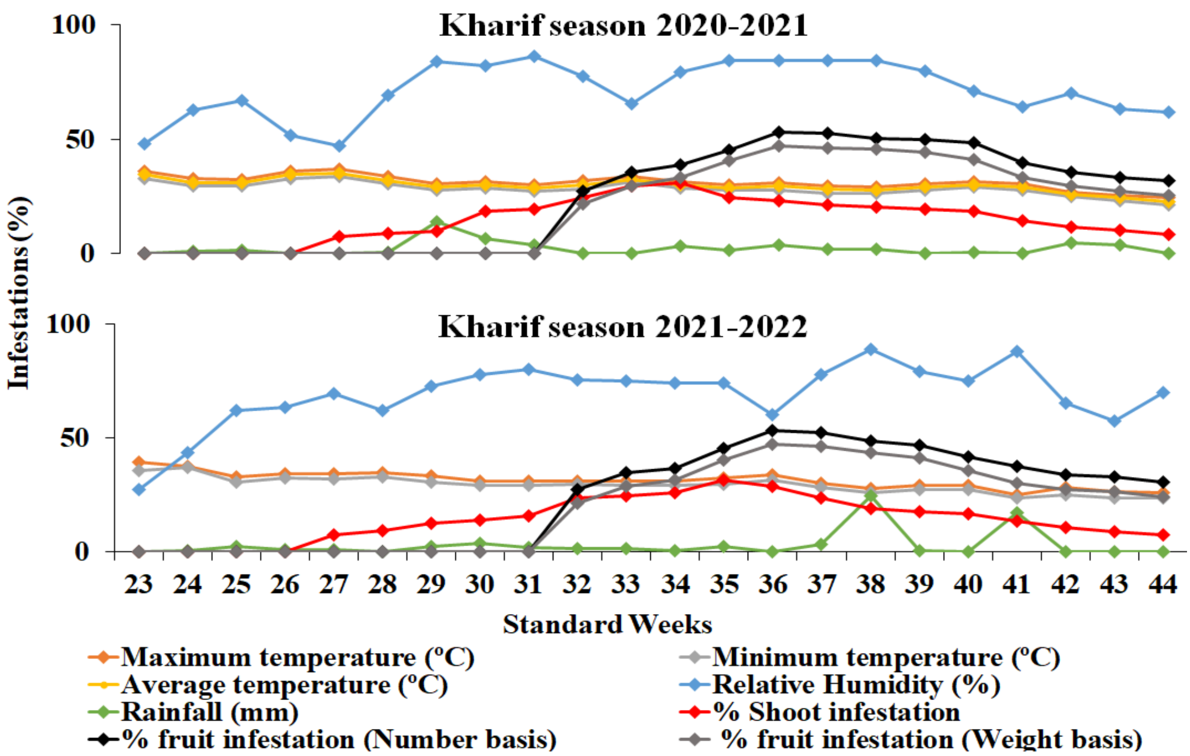

Fig. 2. Shoot and fruit infestation during the Kharif seasons

Table 3. Correlation coefficient (r) of BSBF % shoot infestation with weather parameters

Years	Seasons	Maximum temperature (ºC)	Minimum temperature (ºC)	Mean temperature (ºC)	Relative humidity (%)	Rainfall (mm)
2020-2021	Rabi	0.231^{NS}	0.306^{NS}	0.267^{NS}	-0.182^{NS}	-0.167^{NS}
	Kharif	-0.239^{NS}	-0.223^{NS}	-0.232^{NS}	0.677^{S}	0.060^{NS}
2021-2022	Rabi	0.311^{NS}	0.336^{NS}	0.323^{NS}	-0.235^{NS}	-0.012^{NS}
	Kharif	-0.295^{NS}	-0.274^{NS}	-0.285^{NS}	0.565^{S}	0.128^{NS}

S given on superscript at each value denotes significance at 0.05, and NS denotes non-significance

Table 4. Correlation coefficient (r) of BSFB % fruit infestation (number basis) with weather parameters

Years	Seasons	Maximum temperature (ºC)	Minimum temperature (ºC)	Mean temperature (ºC)	Relative humidity (%)	Rainfall (mm)
2020-2021	Rabi	0.748^{S}	0.798^{S}	0.773^{S}	-0.691^{S}	-0.204^{NS}
	Kharif	-0.509^{S}	-0.488^{S}	-0.500^{S}	0.426^{S}	-0.187^{NS}
2021-2022	Rabi	0.691^{S}	0.706^{S}	0.699^{S}	-0.638^{S}	-0.182^{NS}
	Kharif	-0.589^{S}	-0.589^{S}	-0.591^{S}	0.441^{S}	0.283^{NS}

S given on superscript at each value denotes significance at 0.05, and NS denotes non-significance

Table 5. Correlation coefficient (r) of BSFB % fruit infestation (weight basis) with weather parameters

Years	Seasons	Maximum temperature (ºC)	Minimum temperature (ºC)	Mean temperature (ºC)	Relative humidity (%)	Rainfall (mm)
2020-2021	Rabi	0.721^{S}	0.773^{S}	0.747^{S}	-0.663^{S}	-0.202^{NS}
	Kharif	-0.492^{S}	-0.471^{S}	-0.483^{S}	0.443^{S}	-0.18^{NS}
2021-2022	Rabi	0.658^{S}	0.675^{S}	0.666^{S}	-0.603^{S}	-0.191^{NS}
	Kharif	-0.558^{S}	-0.558^{S}	-0.560^{S}	0.438^{S}	0.287^{NS}

S given on superscript at each value denotes significance at 0.05, and NS denotes non-significance

4. DISCUSSION

The BSFB was present in the brinjal field throughout the year, but its infestation and occurrence levels varied depending on the seasons or months. The infestation was notably lower during the rabi season but increased noticeably during the Kharif season. Several investigations have been done, which reported a reduced incidence of BSFB during the crop grown in the rabi (winter) season instead of the kharif (Summer) seasons. The result was supported by Kariyanna et al. [15], who reported that the BSFB incidence was minimum in rabi and maximum in kharif seasons. Apart from this, Alam et al. [16] and Mannan et al. [17] found similar results, who reported the incidence of BSFB was higher in summer and lower in winter. During the Rabi season of both years, the shoot infestation began in the 1st week of January, peaked in 3rd week of February or 1st week of March, and sustained until 3rd week of April. However, the fruit infestation initiated in the 1st week of February gradually increased and peaked in 1st week of March. It persisted until 4th week of April. These findings were supported by Mannan et al. [17], who observed the lowest fruit infestation in January, with a rate of 5.27%, and the highest in March, with an infestation rate of 31.27%. Moreover, Kariyanna et al. [15] found the highest fruit infestation rate in December, with an infestation rate of 35.14%. The BSFB infestation started from the 4th SMW with a shoot damage rate of 2.66. It peaked at 20% during the 10th SMW, While the fruit infestation initiated during the 8th SMW with 4.50% infestation and peaked during the 12th SMW with 18.30% infestation [18]. The shoot infestation is associated positively with the temperature and negatively with humidity and rainfall. However, the fruit infestation was associated positively with temperature on both number and weight basis while negatively with relative humidity and rainfall during the Rabi season of both studied years.

Several studies supported our results. A positive correlation between infestation and temperature during the crop season was reported by Singh et al., [18]. Similarly, Mathur et al. (2012), Maru & Kumar [19], and Rao & Bhavani [20] also recorded the same result. The larval population also positively correlated with temperature [21]. Relative humidity was also found to influence the seasonal incidence of BSFB. Mathur et al. (2012) reported a negative correlation between infestation and relative humidity. Apart from this, Nayak [21], Singh et al. [18], Maru & Kumar [19], Rao & Bhavani [20], and Bharathi et al. [22] found similar results during the study. Rainfall was also found to influence the seasonal BSFB incidence. The shoot and fruit infestation had negatively correlated with rainfall reported by Maru & Kumar [19] and Rao & Bhavani [20], while Singh et al. [18] found a positive correlation between rainfall and the incidence of BSFB. Similarly, Mathur et al. (2012) and Varma et al. [23] found a positive correlation with rainfall.

During the Kharif season, the commencement of shoot infestation was noticed from 1st week of July and persisted till 1st week of November. The highest occurrence level was recorded during August's 3rd and 4th weeks. In contrast, fruit infestation set in 1st week of August, gradually raised and reached its maximum in 1st week of September, and persisted until 1st week of November. Our results are partially consistent with Tripura et al. [24], who observed that the infestation started in 2nd week of June and 3rd week of July, respectively. It was constant until 2nd week of September and the third week, respectively. They also observed the peak infestation on shoots, 34.20%, and fruits, 46.75%, in 1st and 3rd week of August. Apart from this, Rashid et al. [25] found that the highest infestation occurred from June to September; Radhakrishore et al. [26] observed that BSFB began from the early growth phase and continued up to the harvesting stage; Singh et al. [27] stated that the infestation of shoot occurred in 4th week of August. The highest level of infestation caused by this month was observed in 1st week of June and 4th week of May on shoots. In contrast, the peak infestation on fruits was detected during the 2nd and 3rd weeks of June, two consecutive cropping seasons, respectively [28]. Kolhe et al. [29] recorded that the infestation of the shoot commenced in 3rd week of August with an average infestation rate of 3.85%. With the incidence increasement, the larval population gradually reached its peak level of 33.5% in 3rd week of October. Then it dropped while the percentage of fruit infestation commenced from the 3rd week of September with an average damage of 4.6%. The population increasement was noticed and slowly peaked at 40.5% in the second week of November, and then the population declined. The brinjal shoot and fruit borer activity was noted throughout the crop development phase. According to Gupta et al. [30], the infestation on shoots began to be seen in the fourth week after transplanting (32nd SMW) and peaked (9.92%) in 1st week of October (40th SMW). However, the 4th week of October (43rd SMW) had the most fruit damage (50.2%) brought on by BSFB. In both years, the shoot infestation showed a negative association with temperature, and a positive association with relative humidity and rainfall. On the other hand, fruit infestation displayed a negative association with temperature and a positive association with relative humidity in both study years. However, in the first year, the fruit damage is negatively associated with rainfall (abiotic). Next year, it presented a positive association in number and weight basis. These results are somewhat consistent with the findings of Tripura et al. [24], who reported that shoot and fruit infestation was associated negatively with temperature; Mahajan et al. [31] also recorded the same results. Kariyanna et al. [15] studied the incidence of BSFB on different cultivars and found that the infestation was negatively associated with minimum temperature during Kharif. Singh et al. [27] stated that shoot infestation was not significantly related to temperature, relative humidity, or rainfall. According to Mahajan et al. [31], shoot and fruit infestation is positively associated with relative humidity. Similarly, Varma et al. [23] and Tripura et al. [24] found the same results. Gupta et al. [30] also recorded that shoot damage was positively associated with relative humidity and rainfall, while fruit infestation was associated negatively with relative humidity and rainfall. Mahajan et al. [31] found a positive association between shoot and fruit damage. Patil & Hole [32] recorded that the shoot and fruit damage was negatively associated with rainfall, while the positive association between shoot infestation and relative humidity was negatively associated with fruit damage [33-36].

5. CONCLUSION

The results concluded that the research offers helpful information on the seasonal occurrence of the shoot and fruit borer infestation on brinjal crops in Aligarh, India, during the Rabi and Kharif seasons, respectively. Based on the findings, The shoot infestation was associated positively with temperature and negatively with relative humidity and rainfall during the rabi season in both years. During the Kharif seasons, the shoot infestation is associated negatively with temperature while positively with rainfall and relative humidity. However, fruit infestation is associated positively with temperature and negatively with relative humidity during the rabi season of both years. In the kharif season, fruit infestation is associated negatively and positively with rainfall in the first and second years. At the same time, fruit infestation was associated negatively with temperature and positively with relative humidity in both years. The highest shoot infestation was found in 3rd week of February during Rabi and 3rd week of August during Kharif, while those of the fruit peaked in 1st week of March during Rabi and 1st week of September during Kharif.

The findings of the study may be utilized to develop effective pest management strategies that reduce the effects of the shoot and fruit borer infestation on brinjal crops. Farmers and researchers may use this information to plan the application of pesticides and other precautionary measures that reduce the risk of infestation. Through more research, it may be possible to better understand the effects of other variables, such as soil fertility, crop rotation, and cultural practices, on the prevalence of the shoot and fruit borer infestation favored host crops. Overall, this study greatly advances our understanding of the pest management practices utilized to cultivate brinjal crops in Aligarh, India, and may help farmers boost agricultural output and profitability.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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