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Weather Parametric Impactions and Relative Abundance of Tephritid Fruit Flies associated with Cucumber

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ABSTRACT

Fruit fly (B.cucurbitae) and red pumpkin beetle (A. foveicollis) are the important insect pests inflicting damage on cucumber and other cucurbitaceous crops and commonly known as symbol of yield losses.The results showed that during 2021and 2022 summer season, highest level of fruit infestation by fruit fly was observed on 25th July 2021 and 8th August 2022 with 46.86 and 41.3 per cent fruit infestation, respectively. The correlation studies on fruit fly incidence revealed that there was a significant positive correlation in respect of mean no. of eggs, mean no. of maggots and per cent fruit infestation with maximum and minimum temperature respectively, during both the consecutive years of 2021 & 2022. The data on relative abundance of different insects of cucumber during 2021and 2022 revealed that the fruit fly species, Bactrocera dorsalis (62.27%) was the highest followed by B. tau (15.68%), B. cucurbitae (10.73%), Dacus longicornis (2.47%), Coccinella transversalis (2.45%), Aulacophora foveicollis (2.20%), Micrapsis discolor (1.56%), A. frontalis (1.16%), and Coccinella septumapunctata (1.08%). During 2021 and 2022, the Simpson-Index diversity showed highest value for fruit fly (0.97 and 0.94) followed by predacious coccinellid beetles (0.67 and 0.71) and red pumpkin beetle (0.55 and 0.64), respectively. Whereas, Shannon-Wiener index diversity (H') during 2021 and 2022 observed highest in fruit fly (1.65 and 1.85) followed by predacious coccinellid beetles (1.15 and 1.05) and pumpkin beetle (0.68 and 0.85), respectively.

Keywords: *Population Fluctuation, Correlation, Relative abundance, Simpson index, Shannon-Wiener Index*

1. INTRODUCTION

In Assam, the area grown under cucumber is 6.90 thousand hectares with an annual production of 71.30 metric tons [3]. The climatic conditions of Northeast India, especially Assam are highly conducive for reproduction of fruit fly and other insect pests. So, this region has been considered to be a biodiversity hotspot of tephritid fruit flies [11]. Cucumber is widely consumed as fresh and processed vegetable product. Tephritid fruit flies belonging to the insect order Diptera considered as one of the major important groups of insect pests of cucurbits all over the world with a total of 4000 species [7]. These flies cause major losses in fruits of cucurbits, and are often considered as a target to the intensive insecticide applications for enhancing the commercial production. Nearly, 250 fruit fly species are capable of achieving pest status by feeding on plants of economic importance. Among these, cucurbits fruit fly *B. cucurbitae* commonly known as melon fruit fly has been found to infest more than 80 different host plants, including tomato, peppers, watermelon, cantaloupe, pumpkin, beans, eggplant, cucumber, squash and passion fruit. The extent of losses caused by melon fruit fly *B. cucurbitae* was reported to vary from 30 to 100% depending on the cucurbit species and season [18]. [19] reported around 30% damage on bitter gourd and watermelon in India. The infestation increases at temperatures below 32°C with a relative humidity range between 60% and 70% [5] . It prefers to infest young, green, and soft-skinned fruits.

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It is very much difficult to manage the pests simply through the application of chemical pesticides due to their peculiar biological features. Again, it is necessary to have basic information on the incidence of the pest in relation to weather parameters which help in determining appropriate time of action and suitable method of control. It has been estimated that each male fly removed from the wild fly population by an attractant would represent one unmated female and for decades, these olfactory attractants have been the basis of tephritid detection, monitoring and control. The cuelure traps have been reported to attract *B. cucurbitae* males and this sex attractant is also more effective compared to food lure. Keeping in view, the known efficacy of cuelure as a sex attractant, it becomes highly justifiable to study the population fluctuation of melon fly, *B. cucurbitae* male round the year through the use of cuelure and influence of abiotic parameters such as temperature (minimum, maximum and gradient), relative humidity (minimum, maximum and gradient), rainfall and total sunshine hour per day on its capture. Therefore, the understanding of population fluctuation and relative abundance in relation to losses caused by fruit flies is one the crucial thing which needs to be thoroughly studied. In view of above factors, the present investigation on "Weather Parametric Impactions and Relative Abundance of Tephritid Fruit Flies associated with Cucumber" has been thoroughly studied.

2. MATERIALS AND METHODS

The field experiment was carried out in the experimental farm, Department of Horticulture, Assam Agricultural University, Jorhat during summer 2021 and 2022. The farm is located at 26.75°N and 94.22°E with an average elevation of 116 meters (381 ft). The experiment was conducted in field conditions adopting Randomized Block Design (RBD), with four replications.

The gross area for the experiment was 600 sq. m (30m x 20m). The area was divided into 4 blocks. Each block was further divided into 6 plots measuring 10.5 sq. m (3.5m x 3m) each. A cucumber variety named 'Khira-90' was sown for the present study on population dynamics and crop loos assessment against various insect pests. The crops were raised as per the recommended package of practices of *Kharif* [2] .

2.1 Meteorological observations

The observation on various meteorological parameters *viz*., maximum and minimum temperatures (°C), maximum and minimum relative humidity (%), bright sun shine hours, and rainfall (mm) were collected from meteorological observatory of ICR farm, Department of Agrometeorology, Assam Agricultural University, Jorhat during summer 2021 and 2022.

2.2 Estimation of Per cent Fruit infestation

To estimate the percentage of fruit infestation, samples of fruits were harvested from the selected sites of field and the fruits were observed for infestation level. The incidence was observed based on ovipositional puncture or damage caused by maggot and the percent infestation was worked out by using the following formula as given by [20]

$$\text{Percent fruit infestation.} = \frac{\text{Total no of damaged fruits}}{\text{Total no of fruits}} \times 100$$

Similarly, the fruit infestation based on mean no of eggs was calculated as:

$$\text{Mean no. of eggs (eggs/ puncture)} = \frac{\text{Total number of eggs observed}}{\text{Number of fruits dissected}}$$

Also, the fruit infestation based on mean no of maggots was calculated as:

$$\text{Mean no. of maggots (maggot/ fruit)} = \frac{\text{Total number of maggots observed}}{\text{Number of fruits dissected}}$$

Finally, the correlations were computed between per cent fruit infestation and weather parameters *viz*., maximum temperature, minimum temperature, mean relative humidity, rainfall and sunshine hours. The correlation of mean number of eggs and maggots per infested cucumber with weather parameters were also determined.

2.4 Estimation of Relative abundance and Species diversity of cucumber insect pest during 2021 and 2022

2.4.1 Relative abundance:

Relative abundance of various insect species that were present in cucumber ecosystem during 2021 and 2022 was calculated by the following formula given by [15].

$$\text{Relative abundance} = \frac{\text{No of individuals of one species}}{\text{No of induviduals of all species}} \times 100$$

2.4.2 Species diversity:

The species diversity was calculated by using Shannon-Wiener index given by [17] which could be defined as:

$H' = -\Sigma Pi \ln (Pi)$,

Where,

Pi=S / N, S= Number of individuals of one species, N= Total number of all individuals in the sample, ln= Logarithm to base 'e'.

The higher the value of H', the higher the diversity.

2.4.3 Species evenness:

Species evenness was calculated using the Pielou's Evenness Index (E1) given by [14].

$E1 = H' / \ln(S)$;

Where, H'=Shannon-Wiener diversity index, S=Total number of species in the sample.

3. RESULTS AND DISCUSSION

3.1 Population fluctuation of fruit fly, *Bactrocera spp* during 2021 and 2022

During 2021, the fruit infestation was observed for the first time on 13th June, 2021. However, during this period the mean no. of eggs, mean no. of larvae and per cent fruit infestation with 15.71, 10.24 and 33.15 per cent was observed from the infested fruit, respectively . Subsequently, the fruit infestation gradually increased and peak level of infestation of 46.86 per cent was observed on 25th July, 2021 (Table 1.). Whereas, the mean no. of eggs (20.43) and larvae (13.26) of fruit fly were recorded peak on 2nd August, 2021 is shown in Table 4.4 and graphically represented in Fig 6 and 7. Similarly, during 2022, the fruit infestation was first recorded on 26th June, 2022 with a mean of 13.47 no. of eggs, 10.75 no. of larvae and per cent fruit infestation of 31.5 per cent and peak level of fruit infestation was observed on 9th August, 2022 with 41.3 per cent fruit infestation, whereas, for fruit fly the mean no of eggs (15.10) and larvae (13.25) were recorded to be highest during 2nd August, 2022 and 17th July, respectively (Table 2). The present findings supported the result of [9] where three population peaks was during first and third week of April and first week of May. [13] observed that the peak population of fruit fly was evident during April- May on bitter gourd. However, the result contradicted the observation of [10], where the peak population of *B.cucurbitae* was recorded in May and August and started decreasing trend from October onwards. In similar manner [1] also reported that the high capture of melon fly was recorded in April-June.

3.2 Correlation coefficient analysis of fruit fly with weather parameters during 2021 and 2022

During 2021, the correlation on fruit fly incidence were carried out based on mean no. of eggs, mean no. of maggots and percent fruit infestation and the results revealed that there was a significant positive correlation in respect of mean no. of eggs, mean no. of maggots and per cent fruit infestation with maximum temperature (r=0.596*, r= 0.607* and r= 0.579*) and minimum temperature (r=0.830**, r= 0.838 **and r= 0.832**) (Table 3). Similarly, during 2022, the correlation studies showed that the mean no of eggs, mean no of maggots and per cent fruit infestation by fruit fly established a significant positive correlation with minimum temperature (r=0.737**, r= 0.731** and r= 0.737**), respectively (Table 4). Earlier, a positive association in case of infestation of fruit fly with maximum temperature was also reported by [4]. Similarly, [8] observed that relationship between fruit fly infestation with maximum (r = +0.870) and minimum (r = + 0.730) temperature had shown signification positive correlation. Whereas, the relationship with minimum relative humidity (r =-0.738) was found to be negative. The present findings are supported with [20] who reported that the melon fruit fly showed significant positive correlation with minimum temperature (r= 0.388*), morning (r= 0.372*) and evening relative humidity ®= 0.427).

3.3 Relative abundance of different Tephritid fruit fly species and other insect pests associated with cucumber during 2021 and 2022

The relative abundance of insect pests of cucumber during 2021 and 2022 are presented in Table 5.

The data on relative abundance of different insect pests of cucumber during 2021 showed that among different fruit fly species, relative abundance of *B. dorsalis* was the highest (63.77%) followed by *B. tau* (15.16%), *B. cucurbitae* (11.28%) and *Dacus longicornis* (1.92%). Similarly, the relative abundance of *A. foveicollis* and *A. frontalis* were *1.93* and *1.5 per cent,* respectively. Among the different predacious coccinellid beetles, the relative abundance of *C. transversalis, M discolor,* and *C. septumapunctata* was recorded as 2.43, 1.41 and 0.94 per cent, respectively. A similar trend was also observed during 2022, with highest relative abundance of 61.58 per cent in case of *B. dorsalis* followed by *B. tau* (16.20 %), *B. cucurbitae* (10.18%) and *D. longicornis* (3.01%). The relative abundance of A. *foveicollis* and *A. frontalis* were recorded as 2.48 and 1.16 per cent, respectively. Similarly in respect of predacious coccinellid beetles, *C. transversalis, M. discolor* and *C. septumapunctata* the relative abundance was observed as 2.48, 1.70 and 1.21 per cent, respectively. The results of present investigation were fairly similar with findings of [16] who reported that *B.dorsalis* was the most abundant fruit fly species with relative abundance of 70.6 per cent. Similarly, [15] reported that the relative abundance of *B. correctus* was more than 95 per cent which was contrasting with the results of present findings. It might be due to different crop (sapota and mango) and variation in weather condition prevailing at different places. Similarly, [6] also reported that the relative abundance of red pumpkin beetle was found to be highest (55.1%), followed by aphids (5.18%) and coccinellids (1.4%) in bitter gourd.

The species diversity and evenness of insect pests of cucumber during 2021 and 2022 are presented in Table 6. The Simpson's diversity index computed for various cucumber insect pests during 2021 showed highest value for fruit fly with 0.97 followed by predacious coccinellid beetles (0.67) and red pumpkin beetle (0.55). Whereas, Shannon-Wiener index diversity (H') during 2021 observed highest in fruit fly with 1.65 followed by predacious coccinellid beetles (1.15) and pumpkin Beetle (0.68), respectively. The species evenness pattern during 2021 was recorded highest in fruit fly followed by coccinellids and pumpkin beetle. Similarly, during 2022, both Simpson diversity index and Shannon–wiener index showed highest value in fruit fly (0.94 and 1.85) followed by predacious coccinellid beetles (0.71 and 1.05) and pumpkin beetle (0.65 and 0.85), respectively. Also, the species evenness pattern value during 2022 was observed highest in fruit fly (0.80) followed by predacious coccinellid beetles (0.45) and red pumpkin beetle (0.36) as shown in Table 4.16. Similarly, [12] reported hat Shannon index of diversity of the fruit fly population was maximum during 48th standard matereological week (SMW) of (November) 2015 (H'=1.06), followed by 27th SMW of (July) 2015 (H='0.83). A low H value indicated during particular SMW indicated the low species diversity. The Pielou's evenness (J') estimated ranged from 0.00 to 0.98. Maximum J' value was recorded (J'=0.98 and 0.96 respectively) during 40th and 51st SMW of 2015 and 1st, 3rd and 48th SMW 2016.

4. CONCLUSION AND FUTURE PRESPECTIVES

From the above findings, it was recognized that the estimation of population is a basic necessity for measuring the intensity of a pest population, determining the influence of natural enemies on the populations, assessing the crop losses, monitoring the appearance of the pest, and making decisions on the methods of control to be used. Establishment of the relationships between the populations of a given insect pest, time of its appearance and duration for which it is likely to cause damage to the crop at a vital growth stage and the consequent loss in yield by the pest are of vital importance for working out the economic threshold. Before developing insect pest management programme for specific agro-ecosystem, it is necessary to have basic information on abundance and distribution of pest in relation to weather parameters, as it helps in determining appropriate time of action and suitable effective method of control.

CONFLICT OF INTEREST AND ACKNOWLEDGEMENTS

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Table 1. Population dynamics of fruit fly in cucumber during 2021

Date of observation	Tmax	Tmin	RH(M)	RH(E)	RF (mm)	BSSH	Mean number of eggs	Mean number of larvae	Percent fruit infestation
24.04.2021	32.4	21.4	89	68	32.5	4.6	0.0	0.00	0.00 (0.00)
01.05.2021	25.9	21.1	98	83	192.2	1.7	0.0	0.00	0.00 (0.00)
08.05.2021	26.1	20.6	96	84	51.6	1.5	0.0	0.00	0.00 (0.00)
15.05.2021	28.3	21.2	95	79	52.9	1.9	0.0	0.00	0.00 (0.00)
22.05.2021	28.4	22.5	93	80	75.9	1.4	0.0	0.00	0.00 (0.00)
29.05.2021	31.2	23.7	90	67	14.0	4.8	0.0	0.00	0.00 (0.00)
06.06.2021	32.2	24.9	93	74	48.8	2.6	0.0	0.00	0.00 (0.00)
13.06.2021	33.7	25.9	86	71	55.9	3.6	15.71	10.24	29.94(33.15)
20.06.2021	32.8	25.6	90	76	149.5	4.5	13.81	10.81	39.50 (38.90)
27.06.2021	32.7	25.4	90	76	65.4	3.8	16.21	12.36	41.35 (40.02)
04.07. 2021	33.8	25.7	95	76	194.9	3.9	15.37	11.13	43.43 (41.22)
11.07. 2021	29.3	25.1	93	90	65.4	0.0	14.00	10.10	42.53 (40.70)
18.07. 2021	32.6	25.5	89	79	43.7	2.7	16.98	12.74	45.75 (42.56)
25.07. 2021	31.4	25.2	92	78	74.2	1.8	18.75	11.98	53.25 (46.86)
02.08.2021	31.9	25.4	93	78	78.3	3.5	20.43	13.26	50.93 (46.86)

**Mean of 4 number of replications*

Table 2. Population dynamics of fruit fly in cucumber during 2022

Date of observation	Tmax	Tmin	RH(M)	RH(E)	RF (mm)	BSSH	Mean number of eggs	Mean number of larvae	Percent fruit infestation
07.05.2022	31.6	20.1	87	65	14.1	6.3	0.0	0.0	0.0 (0.0)
14.05.2022	29	21.2	95	75	42.5	2.6	0.0	0.0	0.0 (0.0)
21.05.2022	27.5	21.9	98	86	126.2	0.5	0.0	0.0	0.0 (0.0)
28.05.2022	30.2	21.8	93	70	123.5	5.3	0.0	0.0	0.0 (0.0)
05.06.2022	29.4	23.2	94	78	15	3.8	0.0	0.0	0.0 (0.0)
12.06.2022	33	24.9	95	77	102.5	4.3	0.0	0.0	0.0 (0.0)
19.06.2022	33	25	96	76	146.5	4.8	0.0	0.0	0.0 (0.0)
26.06.2022	31.4	24.9	96	82	35.4	2.4	13.47	10.75	27.67 (31.5)
03.07.2022	33.5	25.4	95	74	41.6	3.6	13.15	11.25	32.2 (34.5)
10.07.2022	30.8	24.8	98	87	121	1.3	14.5	12.5	32.75 (34.9)
17.07.2022	31	25	97	79	75.1	0.9	12.25	13.25	35.9 (36.7)
25.07.2022	30.9	25	97	84	96.4	1.1	10.87	9.5	30.97(33.7)
02.08.2022	33.7	26.4	92	71	24.9	5.8	15.10	12.12	33.97 (35.6)
09.08.2022	33.9	25.8	94	78	169.2	3.7	13.1	12.25	43.62 (41.3)

**Mean of 4 number of replications*

Table 3. Correlation coefficients of abiotic and biotic factors with populations of cucumber fruit fly during 2021

Abiotic and biotic Factors	Correlation Coefficient(r)		
	Mean no of Eggs	Mean no of Larvae	Fruit fly infestation
Maximum Temperature (Tmax)	0.596*	0.607*	0.579*
Minimum Temperature (Tmin)	0.830**	0.838**	0.832**
Relative Humidity (Morning) RH(M)	-0.373	-0.381	-0.334
Relative Humidity (Evening) RH(E)	0.111	0.122	0.167
Rainfall (RF)	0.179	0.201	0.223
Bright Sun Shine Hours	0.124	0.143	0.095

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

Table 4. Correlation coefficients of abiotic and biotic factors with populations of cucumber fruit fly during 2022

Abiotic and biotic Factors	Correlation Coefficient (r)		
	Mean no of Eggs	Mean no of Larvae	Fruit fly infestation
Maximum Temperature (Tmax)	0.463	0.449	0.484
Minimum Temperature (Tmin)	0.737**	0.731**	0.737**
Relative Humidity (Morning) RH(M)	0.256	0.276	0.248
Relative Humidity (Evening) RH(E)	0.309	0.312	0.297
Rainfall (RF)	-0.028	-0.009	0.081
Bright Sun Shine Hours	-0.293	-0.332	-0.308

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

Table 5. Relative abundance (%) of cucumber insect pests during 2021 & 2022

Name of the Insect	2021	2022
B. dorsalis	63.77	61.58
B.tau	15.16	16.20
B. cucurbitae	11.28	10.18
D. longicornis	1.92	3.01
A. foveicollis	1.93	2.48
A. frontalis	1.15	1.16
C septumapunctata	0.94	1.21
C. transversalis	2.43	2.48
M. discolor	1.41	1.70

Table 6. Diversity index of insect pests and natural enemies in cucumber during 2021 & 2022

Insect	Summer 2021			Summer 2022		
	SID	H"	E	SID	H"	E
Fruit fly	0.97	1.65	0.71	0.94	1.85	0.80
Pumpkin beetle	0.55	0.68	0.29	0.65	0.85	0.36
Predacious Coccinellids	0.67	1.15	0.49	0.71	1.05	0.45

**SID= Simpson Index Diversity*
**H'= Shannon-Weiner Index*
**E= Evenness Pattern*

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