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Seasonal incidence of fruit fly (*Zeugodacus cucurbitae*) in cucurbit ecosystem in Tripura, N.E. India

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Abstract
Zeugodacus cucurbitae is one of the most destructive Fruit fly pests which cause extensive damage to cucurbitaceous crops. The present study of two years duration was carried out in cucurbit ecosystem in Tripura to investigate the seasonal incidence of *Z. cucurbitae* in relation to abiotic factors using Para-pheromone lure (cue-lure) baited traps. The population of male fruit flies showed almost similar pattern of population fluctuation through out the study period. Moderate to high population was recorded from February to October and during the cooler months i.e. from November to January the adult activity was low (5-16 flies/trap/week). The numbers of fruit flies captured in cue lure baited traps correlated positively with temperature, relative humidity and rainfall. Maximum temperature, minimum temperature and rainfall have significant influence on *Z. cucurbitae* population.

Keywords: *Zeugodacus cucurbitae*, fruit fly, cucurbits, seasonal incidence, Tripura

Introduction
Zeugodacus cucurbitae (Coquillett), commonly known as Melon Fly, is one of the most serious and destructive pests of cucurbits [3, 12, 15]. This species of fruit fly has a wide host range but plants belonging to the family Cucurbitaceae are preferred most [2, 4, 18, 9]. This serious pest causes destructive damage to cucurbits leading to considerable reduction in the yield and quality [14, 6, 8, 10]. Moreover, they limit the export of cucurbitaceous vegetables from India due to strict quarantines imposed to prevent their spread in international trade.
Incidence of any pest depends mostly on the prevailing climatic conditions and availability of hosts in a particular agro ecosystem. Monitoring of pest population in relation to weather parameters is of great importance in determining appropriate time of action for effective management of the pest.
Among the fruit flies infesting cucurbitaceous vegetables, two species namely *Zeugodacus cucurbitae* (Coquillett) and *Zeugodacus tau* (Walker) are major pests [5, 15, 9]. Keeping in view the above facts, the present experiment was carried out to find out the seasonal incidence of *Z. cucurbitae* and effect of weather parameters on its population dynamics in Cucurbit ecosystem after carefully distinguishing it from its ecological homologue i.e. *Z. tau* under prevailing climatic condition of Tripura so that need based effective management strategies can be taken against this pest in appropriate time.

Materials and Methods
The present investigation on melon fly (*Zeugodacus cucurbitae*) incidence in relation to weather parameters was carried out in farm area of College of Agriculture, Lembucherra, Tripura from July, 2015 to June, 2017. Local varieties of ash gourd (*Benincasa hispida*), bottle gourd (*Lagenaria siceraria*), bitter gourd (*Momordica charantia*), Cucumber (*Cucumis sativus*), pointed gourd (*Trichosanthes dioica*), pumpkin (*Cucurbita moschata*), ridge gourd (*Luffa acutangula*), snake gourd (*Trichosanthes cucumerina*), spiny gourd (*Momordica dioica*), sponge gourd (*Luffa cylindrica*) and water melon (*Citrullus lanatus*) were grown following recommended package of practices except for the plant protection measures to create a cucurbit ecosystem with year round availability of host plants of melon flies.
Traps baited with para- pheromone lures (cue-lure) were installed at ten sites for catching male fruit flies. The traps used for monitoring fruit flies were prepared with plastic mineral water bottles of one litre capacity with three windows each of 1 inch size. Cotton rope of ½ inch's

thickness and 2 inch's length impregnated with a solution of Ethyl Alcohol, Cue lure and DDVP in the ratio of 6:4:2 was suspended from the top of the bottle with the help of a thin iron wire. The old lures were replaced with fresh lures at every 21 days intervals. The traps were hung about 1.5 meters above the ground and a distance of at least 300 m^2 between the traps was maintained to avoid the trap interference effect. Trapped *Z. cucurbitae* males from each trap were brought to the laboratory at every seven days intervals, separated from other trapped flies by observing key taxonomic characters and mean trap catches were calculated for every week throughout the experiment.

Meteorological data used in the present study were collected from ICAR, Lembucherra, Tripura. Correlation and Regression study was made between weekly trap catches of *Z. cucurbitae* and mean weather parameters like maximum temperature, minimum temperature, relative humidity and rainfall for every standard week.

Results and discussion

Seasonal incidence

Almost similar pattern of population fluctuation of *Z. cucurbitae* males were recorded throughout the duration of the present study (Table 1; Fig-1). It is evident from the present study that the adults of this particular species remained active throughout the year in the cucurbit ecosystem except during the winter months i.e. from November to January. During these cooler months the population was low (≤ 20 flies/trap/week). Only 5-16 adult males per trap were captured from 44th SW of 2015 to 6th SW of 2016 and only 7-16 adult males per trap were captured from 44th SW of 2016 to 5th SW of 2017. Low incidence of melon fly during cooler months has earlier been reported by some workers [7, 11, 16]. During 2015-16 lowest trap catches (5 flies/trap/week) were recorded on 49th SW of 2015 and 2nd and 3rd SW of 2016 while during 2016-17 lowest trap catches (7 flies/trap/week) were recorded on 51st SW of 2016 and 2nd and 4th SW of 2017. Through out the remaining period of the year i.e. from February to October months the adult activity was moderate to high. 29-48 flies/trap/week were recorded from 27th to 43rd SW of 2015 with highest trap catches of 48 flies/trap/week on 28th SW. Then there was a sudden decline of adult population from 44th SW of 2015. Then from 7th SW of 2016 the adult fly population gradually became increasing and reached its peak on 21st and 22nd SW of 2016 when 55 flies/trap/week were recorded. Moderate to high incidence of adult flies continued up to 43rd SW of 2016 after which again there was a sudden decline of fly incidence from 44th SW with the onset of winter. The fly activity remained low up to 5th SW of 2017. Then again fly activity gradually increased from 6th SW of 2017 and attained its peak (58 flies/trap/week) on 24th SW of 2017. 23-58 flies/trap/week were recorded from 6th to 26th SW of 2017.

Effect of abiotic factors on fruit fly adult abundance

Studies on the relationship between trap catches of *Z. cucurbitae* and weather parameters during the present work has revealed that there is significant positive correlation with all the weather parameters under study i.e. maximum temperature (r= 0.829) and minimum temperature (r= 0.839), rainfall (r= 0.531) and relative humidity (r= 0.446) at 1% level of significance (Table 2). Positive correlation of melon fruit fly incidence with temperature has earlier been reported by some workers [1, 7, 13, 16].

It is evident from the multiple linear regression analysis between *Z. cucurbitae* and the weather parameters that maximum temperature, minimum temperature and rainfall have significant influence while relative humidity has non-significant influence on seasonal incidence of *Z. cucurbitae* population. The weather factors under study togetherly influenced the fruit fly population to the extent of 79 percent. The multiple linear regression model was $Y=-68.24+2.67\ x_1+0.83\ x_2+0.05\ x_3-0.04\ x_4$. Where, x_1 = Maximum temperature, x_2 = Minimum temperature, x_3 = Rainfall, x_4 = relative humidity (Table 3).

Many workers have studied the seasonal incidence of melon fly (*Z. cucurbitae*) [1, 11, 13, 15]. The present finding is in conformity with Laskar and Chatterjee (2010) [7] who reported that during warm and rainy months the flies were more active as compared to that of dry and winter months and noted significant positive correlation (r) of fly incidence with minimum (r= +0.7596) and maximum temperature (r= +0.7376) and Rainfall (r= +0.4367). Vignesh and Viraktamath (2015) [16] also recorded high incidence of fruit fly during *kharif* and low incidence during *rabi* and observed significant positive correlation of melon fruit fly incidence with minimum temperature (r= 0.388*), morning(r= 0.372*) and evening relative humidity (r= 0.427). Sawai *et al*. (2019) [13] also found significantly positive correlation of the fly catch in the cue lure baited trap with average temperature. Abhilash *et al*. (2017) [1] found significant positive correlation of melon fruit fly incidence with maximum and minimum temperature but significant negative correlation with afternoon relative humidity and rainfall. Raghuvanshi *et al*. (2012) [11] observed abundance of fruit flies in Cue-lure baited traps throughout the year with two peaks; in summer and *kharif* (Autumn) coincided with the 14 SW and 43 SW respectively. They also observed significant positive correlation of adult fruit fly abundance with maximum and minimum temperature. Sunil *et al*. (2016) [15] observed peak of Fruit fly infestation on bitter gourd during last week of September (52%) and in last week of February (33%) and recorded significant positive correlation of fruit fly incidence with rainfall (r = 0.71) and positive correlation with maximum temperature (r = 0.35) and maximum RH (r = 0.59). However, in contrary to the present findings and many other reports as stated earlier Wazir *et al*. (2019) [17] reported that population of *Bactrocera cucurbitae* was highly significant and positively correlated with mean relative morning humidity, relative evening humidity and rainfall but highly negatively correlated with maximum temperature.

Conclusion

It is evident from the present study that the population of *Z. cucurbitae* is positively correlated with the environmental factors of which maximum temperature, minimum temperature and rainfall have significant influence on *Z. cucurbitae*. It is clear from the present findings that adult flies of *Z. cucurbitae* remain very active in the cucurbit ecosystem of Tripura all throughout the year except the winter months. So, the cucurbitaceous crops grown during February to October in Tripura are vulnerable to the attack of *Z. cucurbitae* when the growers should remain alert and strategies for managing this fly species have to be formulated accordingly.

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Table 1: Seasonal incidence of fruit fly (*Zeugodacus cucurbitae*)

Standard week	Weekly catches of *Z. cucurbitae*	Standard week	Weekly catches of *Z. cucurbitae*	Standard week	Weekly catches of *Z. cucurbitae*	Standard week	Weekly catches of *Z. cucurbitae*
Year 2015		Year 2016				Year 2017	
27	46	1	7	27	43	1	10
28	48	2	5	28	45	2	7
29	42	3	5	29	42	3	8
30	41	4	6	30	39	4	7
31	46	5	9	31	44	5	16
32	30	6	16	32	37	6	23
33	36	7	21	33	33	7	27
34	29	8	24	34	36	8	25
35	32	9	27	35	30	9	25
36	40	10	23	36	35	10	32
37	37	11	28	37	37	11	36
38	36	12	36	38	40	12	39
39	43	13	47	39	32	13	29
40	35	14	43	40	35	14	40
41	32	15	54	41	33	15	46
42	38	16	43	42	42	16	39
43	33	17	40	43	40	17	36
44	16	18	42	44	12	18	47
45	14	19	46	45	14	19	42
46	11	20	44	46	12	20	52
47	13	21	55	47	13	21	44
48	11	22	55	48	10	22	47
49	5	23	52	49	8	23	39
50	6	24	48	50	8	24	58
51	8	25	44	51	7	25	43
52	7	26	54	52	9	26	46

Table 2: Correlation co-efficient between weather parameters and incidence of *Z. cucurbitae*

Weather Parameters	Correlation value with Mean weekly trap catches
Maximum Temperature	0.829**
Minimum Temperature	0.839**
Rainfall	0.531**
Relative Humidity	0.446**

(**= significant at 1%, NS = Non-significant)

Table 3: Multiple regression equation between weather parameters and incidence of *Z. cucurbitae*

Weather Parameters	Regression model	Standard Error	P-value
Maximum Temperature (x_1)	$Y=-68.24+2.67\ x_1+0.83\ x_2+0.05\ x_3-0.04\ x_4$ $R^2=0.790$	0.524	0.000
Minimum Temperature (x_2)		0.338	0.015
Rainfall (x_3)		0.012	0.000
Relative Humidity (x_4)		0.151	0.767

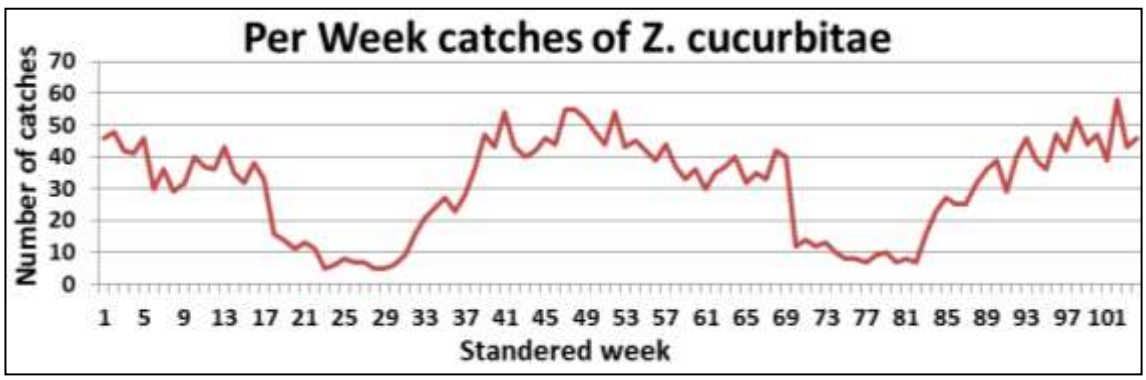

Fig.1: Seasonal incidence of fruit fly (Per Week catches of *Z. cucurbitae)*

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