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Short Communication

Distribution and abundance of cucurbit fruit fly *Zeugodacus* (*Bactrocera*) *cucurbitae* in relation to weather parameters

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The cucurbit fruit fly, *Zeugodacus* (=*Bactrocera*) *cucurbitae* (Coquillett) (Diptera: Tephritidae) is a polyphagous and cosmopolitan pest widely distributed intropical, sub-tropical and temperate countries of the world. It has been observed as a serious pest of cucurbitaceous vegetables and recorded to damage 81 host plants (Dhillon *et al*., 2005), especially the bitter gourd (*Momordica charantia* Linn.), bottle gourd (*Lagenaria siceraria* (Molina) Standl.), cucumber (*Cucumis sativus* Linn.), pumpkin (*Cucurbita moschata* Duch. ex Poir.), muskmelon (*Cucumis melo* Linn.), sponge gourd (*Luffa aegyptica* Mill.) and snake gourd (*Trichosanthes cucumerina* Linn.) (Halder *et al*., 2020; Rai *et al*., 2014a). The tune of crop losses varies from20 to 100%, depending on the cucurbit species and the prevailing weather conditions (Halder and Rai, 2021). It has been observed that the pest infest one or other cucurbits crops round the year in Varanasi region. Furthermore, all the damaging stages except adult stage are found hidden inside the fruits and the damage symptoms are not apparent from outside. Sometimes, the damage by this polyphagous pest becomes so serious that chemical pest control measure was almost unavoidable. Farmers of the region frequently spray 9-13 rounds of synthetic pesticides to control this notorious pest (Halder *et al*., 2018). This practice has led to many fold problems like resistance to pesticides, resurgence and/or outbreak of secondary pest in addition to pesticides residues in food commodities, and killing of non-target organisms (Halder and Rai, 2021).

Monitoring of adult stage and prediction of its prediction is important for the strategic pest management. In fact, the insect pest incidence is an upshot of interaction among host plant, insect and prevailing weather over a time period. Different abiotic parameters *viz*., temperature, rainfall, wind velocity and relative humidity immensely influence the insect population (Halder *et al*., 2017a). So, the prediction or early detection of incidence of any major insect pest with crucial weather conditions that is accountable for its prevalence is of paramount importance. With this in apprehension, the current study was carried out to elucidate the effect of different meteorological parameters on the population buildup of *Z. cucurbitae*in cucurbit ecosystem and also to develop a weather based prediction model for this nefarious polyphagous pest. This will be helpful to initiate management practices well in advance, thus minimizing the excessive usage of pesticides, overall cost of cultivation as well as environmental pollutions.

The experiments were carried out at the research farm of ICAR-Indian Institute Vegetable Research, Varanasi, Uttar Pradesh, India during 2013 to 2018. A series of cucurbitaceous vegetables *viz*., bottle gourd, bitter gourd, pumpkin, rigde gourd, sponge gourd, pointed gourd, cucumber, ivy gourd, spine gourd etc. are grown almost thorough out the year at the experimental farms of the institute. Usual crop husbandry measures were undertaken except plant protection measures. In addition to this, data were also taken from the nearby cucurbits growing farmers' field at regular intervals.

The regular monitoring at weekly intervals for the fruit fly incidence was recorded by installing Cuelure bottle traps (ethanol, insecticide and Cuelure (6:1:2) coated in wooden block) @ 4-5 traps/ha (Rai *el al*., 2014b) during morning hours (in between 10 to 11 am). Nine traps were installed round the year and the lures (*i.e.,* wooden blocks) were replaced after 1 month interval. Since the experimental farm of the institute is equipped with a meteorological observatory, the daily data on weather parameters were recorded there for the purpose.

The current growth of any insects is the outcome of the nutrient status and environmental condition of the preceding days/weeks (Vennila *et al*., 2016). So, the current pest population

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Table 1: Correlation coefficient (r) of incidence of cucurbit fruit fly, *Z. cucurbitae* with abiotic factors during study period

Sr No.	Weather parameters	Correlation co-efficient
X_1	Maximum temperature (^{0}C)	0.447**
X_2	Minimum temperature (^{0}C)	0.035
X_3	Relative humidity (morning)	- 0.570**
X_4	Relative humidity (evening)	-0.724**
X_5	Rainfall (mm)	-0.266*
X_6	Bright Sunshine (hrs)	0.448**
X_7	Evaporation (mm)	0.439**
X_8	Wind speed (km h^{-1})	-0.080

Observation based on the average of 52 weeks data over six years i.e., 2013-2018

* Significant at 0.05 level (2-tailed); ** Significant at 0.01 level (2-tailed);

was correlated with meteorological parameters of the preceding one week and multiple regression model developed accordingly. For simple correlation, SAS software (version 9.3) was used for statistical analysis adopting the standard procedure.

Six year (2013 to 2018) mean data revealed the occurrence of cucurbit fruit fly throughout the year with two major peaks during 13 (last week of March) and 46 (third week of November) standard meteorological week (SMW) and the corresponding adult fly caught per trap were 90.33 and 96, respectively. Moreover, the population of fruit flies remained at low during cooler and rainy months of the year being the lowest during the January month in the region. Thus the active periods of the pest were noted from 11 to 24 SMW and 42 to 49 SMW on the region.

Different abiotic parameters *viz*., maximum and minimum temperature, relative humidity (morning and evening), sunshine hour, evaporation, rainfall and wind velocity had been recorded and their possible role in abundance of *Z. cucurbitae* were elucidated. It is evident that maximum atmospheric temperature had highly significant positive correlation with the fruit fly population during the study period and the correlation co-efficient (r) value was +0.447** (Table 1). Similar observation was also noted on minimum temperature and the corresponding r-value was +0.035.

Maximum and minimum temperatures had significant and positive correlation with the number of guava fruit fly (*Bactrocera zonata*) caught in Delhi (Sharma *et al*., 2015). In another study, Banerji *et al*., (2005) from West Bengal, India observed that the per cent bitter gourd fruit infestation by melon fly, *B. cucurbitae* was positively correlated with maximum temperature during kharif season and minimum temperature during rabi and summer seasons. Halder *et al*., (2017a & b) also reported increase in *Nesidiocoris cruentatus* on bottle gourd and cucumber moth, *Diaphania indica* on bitter gourd were associated with period of high temperature.

Similarly, the relative humidity at morning and evening had highly significant negative correlation with pest incidence (r = -0.570** and -0.724**, respectively). Relative humidity was substantially higher during morning than the evening. Rainfall had also showed a negative correlation (r = -0.266) with the abundance of fruit fly. Infestation of melon fruit fly, *B. cucurbitae* on bitter gourd showed positive correlation with maximum relative humidity (Banerji *et al*., 2005). Morning and evening relative humidity had proven positive and significant correlation with the abundance of guava fruit fly, *B. zonata* (Sharma *et al*., 2015). Rainfall and rainy days had positive and highly significant correlation with fruit flies (*Bactrocera tau*) caught per trap in Passion fruit orchard in Indonesia (Hasyim *et al*., 2008). Liu (1983) observed that typhoons and heavy rains for several days, population of *Bactrocera dorsalis* was declined to low level.

Another important meteorological parameter *viz*., sunshine duration had shown positive and significant correlation (r= +0.448**) with the cucurbit fruit fly population. Form the Table 1 it is depicted that rate of evaporation had positive correlation (r= +0.439**) with *Z. cucurbitae* population during the year 2013-18. Sharma *et al*. (2015) confirmed that bright sunshine hour exhibited positive relationship with fruit fly (*B. zonata*) trap catches in guava. A negative and non-significant correlation (r = -0.080) was observed between wind velocity and *Z. cucurbitae* population on cucurbitaceous vegetables. Earlier Halder *et al*., (2019) also documented a significant and negative correlation (r = -0.452**) with whitefly population in okra.

The stepwise forward selection method of model fitting was followed that begins with no variables in the model. Then variables are added subsequently one by one to the model, and the F-statistic for a variable to be added must be significant with improvement in coefficient of determination (R^2) of the model. The model thus derived for fruit fly incidence (Y) is as follows

$$Y=-216.70+9.95x_1-4.85x_2+2.60x_3-2.11x_4-12.66x_5+0.69x_6+0.56x_7+0.14x_8$$

It can be inferred that the information so derived from the current study could be helpful to predict the population of fruit fly, *Z .cucurbitae*, a polyphagous and persistent cucurbitaceous pest, on at any given time and the develop model will be useful to initiate the suitable control measures to avoid the high yield loss.

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