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## Monitoring Fruit Fly Species in Pumpkin Field and Detection of Melon Fruit Fly *Zeugodacus cucurbitae* from Infested Cucumber Fruits

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### ABSTRACT

Numerous fruit fly species pose enormous threats to fruit and vegetable production worldwide, resulting in both quantitative and qualitative losses. The experiment evaluated the effectiveness of five different traps in a pumpkin (*Cucurbita pepo*) field located in Mahalaxmi municipality-6, Lalitpur district, Nepal, from April to June 2024. Yellow sticky trap, plastic bottle trap, bucket trap, steiner trap and plastic glass trap were used as treatments, provided with a cotton wick soaked in 0.5 ml of cue lure (except yellow sticky trap) placed at 1 m height on a standing stick in the pumpkin field. Throughout the collection, *Zeugodacus cucurbitae* was the most abundant, with a total of 1300 flies, followed by *Zeugodacus tau*, *Bactrocera dorsalis*, and *Bactrocera nigrotibialis*, respectively. In total, the highest average capture was led by the steiner trap, followed by the bucket trap, while the yellow sticky trap was the least effective. Laboratory rearing of fruit flies resulted in the emergence of a single species, *Zeugodacus cucurbitae*. Average pupal size was  $5.67 \pm 0.052$  mm length,  $2.15 \pm 0.041$  mm breadth, and weighed  $14.90 \pm 0.31$  mg. Female adults were larger than males, measuring  $7.59 \pm 0.18$  mm body length and  $14.76 \pm 0.31$  mm wingspan, compared to males ( $6.98 \pm 0.12$  mm length and  $14.65 \pm 0.24$  mm wingspan), and the ovipositor measured  $1.75 \pm 0.056$  mm. This indicates a single species oviposits in a single fruit.

**Keywords:** Fruit fly, monitoring, rearing, traps, *Zeugodacus cucurbitae*

### INTRODUCTION

Fruit flies are attacking fruits and vegetables and they belong to the order Diptera & family Tephritidae (Gupta & Regmi, 2022). Numerous fruit fly species constitute enormous threats to fruit and vegetable production throughout the

world, causing both quantitative and qualitative losses (Vargas et al., 2015). They are frugivorous species and several are the important species of plant quarantine in fruit growing areas (Tarno et al., 2022). At present, 4352 species in 483 genera are known around

the world (Kapoor, 2002). Thirty fruit fly species are known to be found in Nepal (Adhikari, 2025; & Adhikari et al., 2022). Environmental conditions affecting host availability are the factors influencing the distribution of various species of Tephritidae (Tarno et al., 2022). It has complete metamorphosis and is found to have four different stages such as, egg, larvae (maggot), pupa and adult (Sohrab et al., 2018). The most common among them are *Bactrocera dorsalis*, *Bactrocera zonata*, *Zeugodacus tau*, and *Zeugodacus cucurbitae* in Nepal (Karki et al., 2023). The pest can cause direct damage to fruits and vegetables which can lead upto 90-100% yield loss (Sharma et al., 2015). Monitoring fruit flies using lured trap is one of the male annihilation techniques that reduces the fruit fly population in subsequent year (Ndlela et al., 2016). This is due to deprivation of female fruit flies from reproduction.

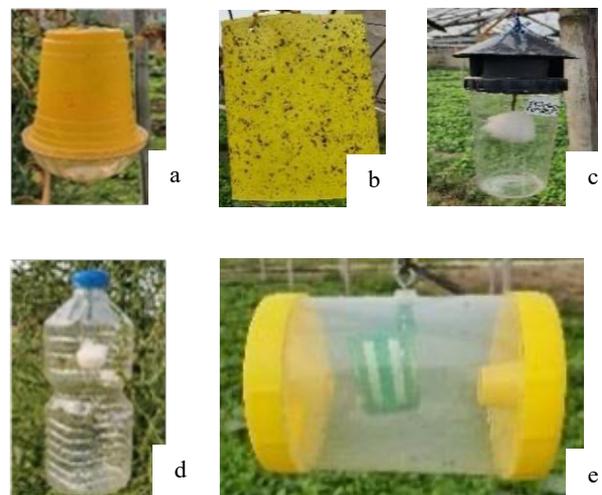
Despite the impact of fruit fly infestations in cucurbit crops, there is a lack of detailed research on the oviposition behavior of fruit flies, specifically the phenomenon of one fruit being oviposited by only one fruit fly species. The existing literature provides limited insight into the exclusive oviposition of one fruit fly per fruit in cucurbits. This gap in knowledge hinders the development of targeted control measures and integrated pest management strategies to mitigate fruit fly damage effectively. The objective of this study was to determine the efficacy of different traps while monitoring fruit fly in the pumpkin field at Mahalaxmi municipality-6, Lalitpur and identify the species trapped. Likewise, to detect fruit fly species emerged from infested cucumber in the laboratory.

## METHODS

### Field study

The experiment was conducted in RCBD design at Mahalaxmi municipality-6 of Lalitpur district, Nepal. There were a total of 5 treatments, Plastic glass trap (Figure 1a), yellow sticky trap (Figure 1b), bucket trap (Figure 1c), plastic bottle trap (Figure 1d), and steiner trap (Figure 1e) with 4 replications of each. Each treatments were placed 5 m apart and 1 m above

the ground. However, in the case of plastic bottles (Figure 1d), 1.3 cm diameter holes were made 5 cm apart; that way, 4 holes were made in each trap. Trap placement was performed by randomization method. Thermo-hygrometer HTC-2 was used for measuring temperature and relative humidity throughout the experiment. Fruit flies trapped in each trap were observed and collected every week. Each treatment (except yellow sticky trap) contained a cotton wick with 0.5 ml cue lure which was applied with the help of a syringe. The lure was replaced after every fourteen days and also the sticky trap. The process was continued for three months from April to June 2024 and the collected files were taken to the lab for species identification.

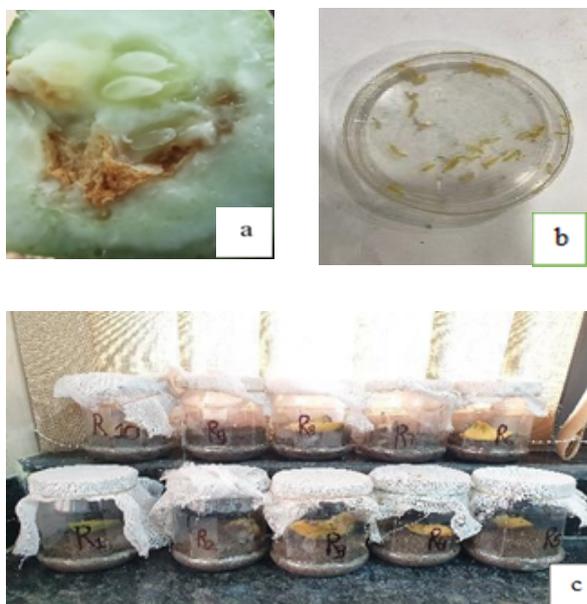


**Figure 1.** a-Plastic glass trap, b-Yellow Sticky trap, c-Bucket trap, d-Plastic bottle trap, e-Steiner trap.

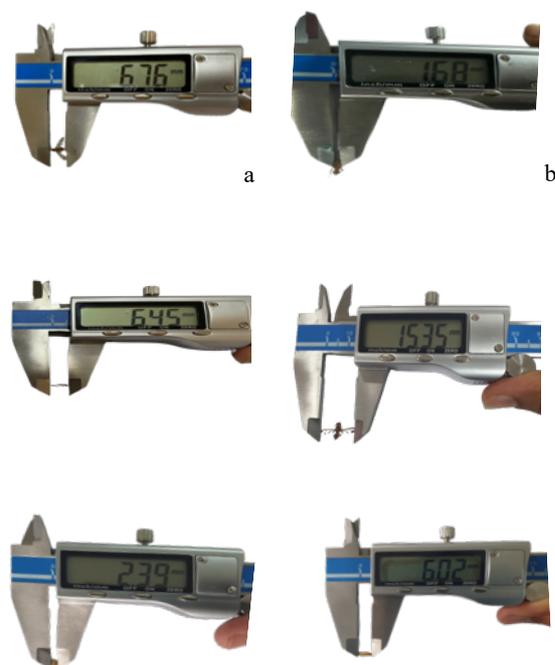
### Laboratory study

For rearing; the maggot infested cucumbers were collected from the field of Kawasoti-15, Nawalparasi east, Nepal. All of them were Kamini variety and they were cut open (Figure 2a) to take out maggots (Figure 2b) and were reared in the laboratory of Plant Quarantine and Pesticide Management Centre, Hariharbhawan, Lalitpur, Nepal (Figure 2c). Maggots from individual infested fruit were handled separately. Both mature and immature larva were kept with the infested part of the fruit in ten similar rearing jars of 8 cm diameter and 11 cm height. Muslin cloth was used for covering the jar and rubber

band to fix it (Figure 2c). Rearing media was used as soil having 14.25% moisture and for moisture management, muslin cloth covering the experiment sample was wetted every day in running water and squeezed until the palm was just wet.



**Figure 2.** a- Infested fruit with maggots, b- Maggots from infested fruit, c- Rearing jar with infested fruit.



**Figure 3.** a-Adult length measurement, b-Adult breadth measurement, c-Wing measurement, d-Adult wing span

measurement, e-Pupa breadth measurement, f-Pupa length measurement.

Measurement of morphometric: Four digit weighing machine OHAUS was used to weigh larva, pupa and adult and Vernier caliper BT 4095 measured the morphometry of pupa and adults (Figure 3).

Measurement of temperature and R H: Thermo-hygrometer HTC-2 was used for measuring temperature and relative humidity throughout the experiment. Temperature and relative humidity data were taken daily until all adult emergence.

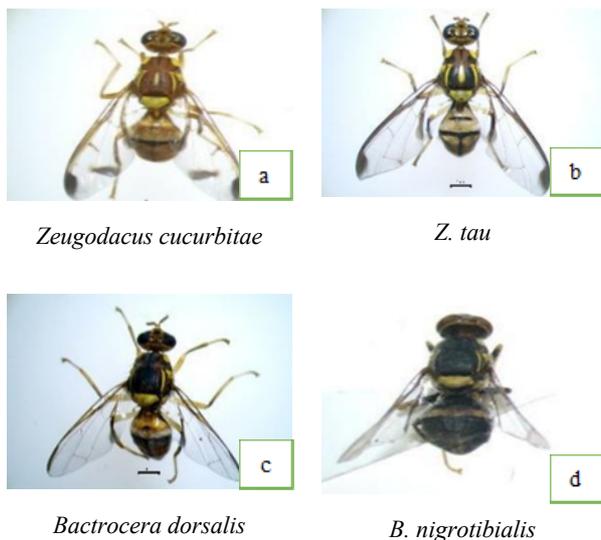
## RESULTS AND DISCUSSION

### Fruit fly species:

The average temperature of field during the study was 29.56°C with minimum temperature being 26.00°C and maximum being 34.05°C. Likewise, the average relative humidity during the study was 67.81% with minimum being 47.50% and maximum of 80.50%. In the first week of trap placement, no fruit fly species were collected in the trap. Gradually, fruit flies count increased from April to June. The total fruit flies collected at the end of eleventh week was 1460 (Table 1). The four species captured were, *Zeugodacus cucurbitae* (Figure 4a), *Z. tau* (Figure 4b), *Bactrocera dorsalis* (Figure 4c), and *B. nigrotibialis* (Figure 4d); out of which *Z. cucurbitae* was the most abundant with total count of 1300 (90.21 %) (Table 1).

**Table 1.** Total number of fruit flies species caught by all traps

Fruit fly species			
<i>Z. cucurbitae</i>	<i>Z. tau</i>	<i>B. dorsalis</i>	<i>B. nigrotibialis</i>
1300	110	47	3



**Figure 4.** Fruit fly species caught in traps

Though traps were set from April, 2024, most caught were seen during June and July. *Z. tau* was the second most abundant species in the experiment with a count of 110 (Table 1). Significant amount of both species can be attracted by cue lure is also stated by (Regmi et al., 2024). This was followed by *B. dorsalis* having a total count of 47 (Table 1) Karki et al. (2023) also reported that *B. dorsalis* was attracted to cue lure traps, particularly during periods of high fly abundance, based on their farmer survey and fruit fly monitoring in citrus orchards of Ramechhap district. Three *B. nigrotibialis* occupying 0.20% of the total capture. According to the NCBI (2022), the COX1 gene sequence of *Bactrocera nigrotibialis*, this species can also be attracted to cue-lure, which has been earlier reported by Adhikari (2025) & Adhikari et al. (2022).

#### Fruit fly trapped in different traps

The data show significant differences ( $p < 0.001$ ) in the mean number of fruit flies captured across the different trap models. Steiner trap was the most effective, capturing the highest mean number of fruit flies (121.25), which significantly outperformed all other trap models (Table 2) which is similar with the findings of (Kean et al., 2024). Bucket trap was the second most effective, capturing an average of 89.50 flies (Table 2), which was still significantly

different from the Steiner trap but better than the remaining traps.

**Table 2.** Mean number of fruit flies trapped in different traps

Trap types	Mean number of fruit flies trapped
Plastic glass trap	71.25 <sup>c</sup>
Yellow sticky trap	18.50 <sup>d</sup>
Steiner trap	121.25 <sup>a</sup>
Plastic bottle trap	64.50 <sup>c</sup>
Bucket trap	89.50 <sup>b</sup>
F-probability	***
LSD (0.05)	10.64
SEM ( ± )	3.98
Grand mean	73.00
CV%	9.46

In a column, means followed by a similar letter (s) are not significantly different whereas, means followed by a dissimilar letter (s) are significantly different as per DMRT; \*\*\*denotes level of significance at 0.001 and CV denotes coefficient of variance.

#### Average number of fruit fly species caught by each trap

Table 3 indicates that there are significant differences ( $p < 0.001$ ) among the five cue lure trap models in their ability to capture *Z. cucurbitae* (Table 3). The Steiner trap captured a significantly higher number of fruit flies with an average sum of 108.75 flies per trap (Table 3). This was followed by the bucket trap, (80.50) flies per trap, followed by Plastic glass trap (62.50) which was significantly at par with plastic bottle trap with 58.25 average flies per trap. Yellow sticky trap, with an average capture rate of only 15 flies, was the least effective and significantly different from all other traps. Similarly, *Z. tau* was also significantly high in the steiner trap with the mean of 8.00 flies per trap, followed by the plastic glass trap (6.00); which was significantly at par with the bucket trap with the mean of (6.0). This was followed by the bottle

trap with the mean of (4.50) and yellow sticky trap being the least to catch the flies (Table 2).

**Table 3.** Average number of fruit fly species caught in each trap

Traps	Average number of fruit fly species caught			
	<i>Z. cucurbitae</i>	<i>Zeugodacus tau</i>	<i>Bactrocera dorsalis</i>	<i>B. nigrotibialis</i>
Plastic glass trap	62.5 <sup>0<sup>c</sup></sup>	6.00 <sup>b</sup>	2.50 <sup>bc</sup>	0.25
Yellow sticky trap	15.0 <sup>0<sup>d</sup></sup>	3.00 <sup>d</sup>	0.50 <sup>d</sup>	0.25
Steiner trap	108.75 <sup>a</sup>	8.00 <sup>a</sup>	4.25 <sup>a</sup>	0.25
Plastic bottle trap	58.25 <sup>c</sup>	4.50 <sup>c</sup>	1.50 <sup>cd</sup>	0.00
Bucket trap	80.50 <sup>b</sup>	6.00 <sup>b</sup>	3.00 <sup>b</sup>	0.00
F - probability	***	***	*	ns
LSD (0.05)	10.94	0.68	1.22	
SEM (±)	4.10	0.25	0.45	0.16
CV (%)	10.93	8.13	33.86	182.57
Grand mean	65.00	5.50	2.35	0.15

In a column, means followed by a similar letter (s) are not significantly different but, means followed by a dissimilar letter (s) are significantly different as per DMRT; SEM= Standard error of mean, CV= Coefficient of variation, \*\*\* denotes level of significance at 0.001, \* denotes level of significance at 0.005 and ns denotes non-significant

Likewise, *B. dorsalis* was also seen during the collection whose grand mean was 2.35 throughout the experiment. Also, the average number of catches were seen significantly high in Steiner traps with the mean of 4.25 followed by bucket trap (3.00) which was statistically similar to plastic glass trap (2.50). The average count was then seen higher in plastic bottles (1.50) but was statistically similar with the catch of yellow sticky traps (0.50). In contrast, the data for *B. nigrotibialis* showed very low and non-significant (ns) differences between traps since it was not found in bucket and plastic bottle traps.

#### Duration of pupa and adult emergence

On an average, all maggots (different instars) pupate from 2-8 days while having average duration for pupation  $4.9 \pm 0.24$  days which was similar with the findings of (Dhillon et al., 2005; Pradhan et al., 2020; Vigneswaran et al., 2016). The duration of pupation however differs with temperature and relative humidity (Narayanan & Batra, 2007). All the emerged fruit flies from the reared maggots collected from infested fruits were identified as *Z. cucurbitae*. It took  $14.49 \pm 1.65$  days on an average to emerge, ranging from 11 days to 17 days. Out of 64 pupae, 61 resulted in adult emergence, concluding 95.31% of adult emergence with twenty one female and forty male. The average lab temperature during maggots rearing was found to be 28.80°C with a minimum of 27.00°C and maximum 30.60°C. The average relative humidity was 67.52% while minimum 52.00% and maximum 72.50%.

**Table 4.** Duration of pupa and adult emergence of *Zeugodacus cucurbitae*

Stage	Parameters	Mean ± S.E (days)	Range (days)
Pupae	Duration of pupation from maggots	$4.90 \pm 0.24$	2-8
Adult	Duration of adult emergence from larval stage	$14.49 \pm 0.21$	11-17

### Weight of pupa and adult fruit flies

The weight of pupa ranged from 3.50-26 mg while the mean weight being  $14.90 \pm 0.31$  mg (Table 5). The weight of pupa seemed quite larger to the weight of both male and female flies this is because during metamorphosis, significant dehydration occurs as tissues mature, resulting in a lower adult weight (Nation, 2022). The average male weight ranged from 0.38-8.2 mg while the same averaged  $4.99 \pm 0.29$  mg (Table 5). However, the female weight was ranging from 1.60-9.50 mg with mean being  $5.15 \pm 0.45$  mg (Table 5) was greater than that of the male due to its demand for reproduction (Chen et al., 2015).

**Table 5.** Weight of pupa and adults of *Zeugodacus cucurbitae*

Parameter	Mean $\pm$ S.E (mg)	Range (mg)
Adult female (n=21)	$5.15 \pm 0.45$	1.60-9.50
Adult male (n=40)	$4.99 \pm 0.29$	0.38-8.20
Pupa (n=64)	$14.90 \pm 0.31$	11.0-26.0

n= Number of sample taken for measurement

### Length and breadth of pupa and adults

The length and breadth of pupa were taken after pupation which was observed daily during the research time. Out of 64 pupae, the average length was  $5.67 \pm 0.41$  mm ranging from 4.05-6.21 mm. Similarly, the breadth of the pupa ranged 0.58-2.61 mm with the average of  $2.15 \pm 0.25$  mm (Table 6) which aligns with the findings of (Gaddanakeri & Rolania, 2020; Pradhan et al., 2020). The average adult length and breadth was however larger in comparison to the pupa which was similar with the findings of (Chaudhary et al., 2024; Gaddanakeri & Rolania, 2020; Pradhan et al., 2020). The female length and breadth averaged  $7.59 \pm 0.18$  mm and  $2.20 \pm 0.31$  mm ranging from 5.75-9.42 mm and 1.71-2.63 mm respectively (Table 6). The male length averaged  $6.98 \pm 0.12$  mm which varied from 4.32-8.45 mm and breadth of  $2.18 \pm 0.054$  mm

with the range of 0.61-2.65 mm without wings attached.

**Table 6.** Length and breadth of pupa and adult of *Zeugodacus cucurbitae*

Life stages	Length		Breadth	
	Mean $\pm$ S.E. (mm)	Range (mm)	Mean $\pm$ S.E. (mm)	Range (mm)
Adult male (n=40)	$6.98 \pm 0.12$	4.32 - 8.45	$2.18 \pm 0.054$	0.61-2.65
Adult female (n=21)	$7.59 \pm 0.18$	5.75-9.42	$2.20 \pm 0.068$	1.71-2.63
Pupa (n=64)	$5.67 \pm 0.052$	4.05-6.21	$2.15 \pm 0.041$	0.58-2.61

n= Number of sample taken for measurement

### Wing and wingspan of adults

The wing length of adult male ranged 3.27-7.19 mm after detaching from the adult body; with an average of  $6.27 \pm 0.67$  mm (Table 7). While the expanded wing span ranged from 7.20 mm to 16.30 mm having mean of  $14.65 \pm 1.54$  mm (Table 7). In the case of adult fruit fly females, average wing length ranged from 4.12-7.65 mm and mean was  $6.47 \pm 0.75$  mm (Table 7). While the wing span ranged from 10.50-16.52 mm with the average of  $14.76 \pm 1.44$  mm which is greater than that of the male average wing and wing span length (Table 7) which is more or less similar with the findings of (Chaudhary et al., 2024; Gaddanakeri & Rolania, 2020). Likewise, the ovipositor length of females were measured to be  $1.75 \pm 0.26$  mm on an average.

**Table 7.** Wing and wing span length of male and female adults of *Zeugodacus cucurbitae*

Life stages	Parameters	Mean $\pm$ S.E (mm)	Range (mm)
Adult female	Wing (n=21)	6.47 $\pm$ 0.16	4.12-7.65
	Wing span (n=21)	14.76 $\pm$ 0.31	10.50-16.52
Adult male	Wing (n=40)	6.27 $\pm$ 0.10	3.27-7.19
	Wing span (n=40)	14.65 $\pm$ 0.24	7.20-16.30

n= Number of sample taken for measurement

### Morphological characteristics of *Z. cucurbitae* observed

Adults of *Z. cucurbitae* were medium sized with large black facial spots in head. Scutum with three reddish-brown lemon-yellow coloured vertical stripes called vittae. The scutellum was yellow without any markings. Abdomen was orange-brown in colour with narrow transverse fuscous separating segments. Three pairs of legs were visible. Wings had two spots, one at apex region and the other at dm-cu cross vein (Figure 4a). Females also had needle-shaped ovipositor.

### CONCLUSION

This study monitored fruit fly populations in a pumpkin field using cue lure and five different trap models: steiner trap, bucket trap, plastic glass trap, plastic bottle trap, and yellow sticky trap. Four different species of fruit flies were captured during the collection; *Z. cucurbitae*, *Z. tau*, *B. dorsalis*, and *B. nigrotibialis*. The results demonstrated significant differences in trap efficacy for

capturing fruit flies. Among the traps, the steiner trap was the most effective. The bucket trap was the second most effective, followed by the plastic glass trap and the plastic bottle trap, which had similar performance. The yellow sticky trap, on the other hand, captured the fewest fruit flies, making it the least effective among the models tested. In case of rearing, the morphometric analysis of the pupae, including measurements of length, breadth and adults wing, wing span, ovipositor (female) along with length and breadth and visual observations of wing (spots at apex of costal band and dm-cu regions), thorax (red brown color, three lateral vittae), confirmed that only one fruit fly species oviposited per fruit. This finding suggests that there is exclusion of competition among fruit fly species when oviposition.

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