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BIOLOGY, MORPHOMETRY, AND REPRODUCTIVE POTENTIAL OF MELON FRUIT FLY (*Zeugodacus cucurbitae* COQUILLETT) ON BITTER GOURD

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ABSTRACT

The melon fruit fly, *Zeugodacus cucurbitae* (Coquillett) (Diptera: Tephritidae), a major pest of cucurbits, is responsible for severe yield losses as well as trade restrictions due to its quarantine importance. The present study examined the biology, morphometry, and reproductive potential of *Z. cucurbitae* on bitter gourd (*Momordica charantia*) during two consecutive *Kharif* seasons (2023 and 2024) at OUAT, Bhubaneswar, Odisha (East & South Eastern Coastal Plain Zone) and ICAR-IIVR, Varanasi, Uttar Pradesh (Middle Gangetic Plains), respectively. Laboratory-reared populations were assessed for developmental duration across the life stages, their morphometric traits, adult longevity, female fecundity, and male: female ratio. Minor spatial variations in the developmental dynamics of *Z. cucurbitae* was attributable to differences in populations established from maggots collected from infested fruits in Bhubaneswar and Varanasi. At Bhubaneswar, the fruit fly had a total life span of 37.45 ± 3.05 days in males and 41.30 ± 2.32 days in females, whereas at Varanasi the life span lasted for 40.90 ± 1.84 days in males and 45.55 ± 3.06 days in females. The durations of embryonic, maggot, and pupal stages also showed minor locational variation between the two populations. Morphometric parameters, including egg, maggot, pupal dimensions and adult measurements (length and width) exhibited minor variation between locations, with females consistently larger than males. High fecundity (78-81 eggs female^{-1}) and a slightly male-biased sex ratio (1.15-1.24:1) were observed at both the locations. The study demonstrated population-level developmental variability and phenotypic plasticity in *Z. cucurbitae* even under uniform laboratory conditions.

Keywords: Biology, bitter gourd, developmental duration, fecundity, morphometry, *Zeugodacus cucurbitae*

INTRODUCTION

The melon fruit fly, *Zeugodacus cucurbitae* (Coquillett) (Diptera: Tephritidae), is among the most destructive pests of cucurbit crops worldwide and is recognized as a quarantine pest in many countries due to its rapid dispersal ability and severe economic impact (Jang *et al*., 2017). Its quarantine status imposes strict phytosanitary regulations that significantly affect international trade of host commodities (CABI, 2018; EPPO, 2024). The global importance of melon fruit fly is reinforced by its exceptionally high reproductive capacity, wide host range exceeding 125 plant species, and remarkable adaptability across the diverse climatic conditions (Dhillon *et al*., 2005a; Hadapad *et al*., 2019; Kayattukandy *et al*., 2025), enabling successful establishment in varied agro-ecological regions. In India, *Z. cucurbitae* reportedly causes 30 to 100% yield losses in cucurbits, depending on host species, season, and prevailing agro-climatic conditions (Ladania *et al*., 2008; Hadapad *et al*., 2019; Kayattukandy *et al*., 2025). Population dynamics and infestation severity are strongly influenced by abiotic factors such as temperature and relative humidity, which favour rapid population buildup and extensive fruit damage under conducive conditions (Gaddanakeri *et al*., 2020). Yield losses up to 77% have been reported during peak infestation periods in cucurbit crops, including bitter gourd, highlighting the severe economic threat posed by the pest (Sarada *et al*., 2022).

Bitter gourd (*Momordica charantia* L.) is one of the most susceptible hosts of *Z. cucurbitae*. Host-associated traits such as volatile chemical cues, nutrient-rich tissues, and relatively soft fruit pericarp facilitate oviposition, larval development, and survival, resulting in severe losses through reduced marketable yield and accelerated post-harvest decay (Dhillon *et al*., 2005b). In major cucurbit-growing regions of India, including eastern Uttar Pradesh and adjoining areas, fruit damage in untreated fields frequently exceeds 50% during peak infestation periods (Bhardwaj *et al*., 2022; Nithya *et al*., 2025; Sharma *et al*., 2025), underscoring the need for improved, host-specific management strategies. A sound understanding of the biology of *Z. cucurbitae* on bitter gourd is essential for developing climate-and host-informed integrated pest management (IPM) approaches. Biological parameters such as developmental duration, morphometric traits across the life stages, and female fecundity are critical determinants of population growth and infestation potential. Morphometric attributes reflect host suitability and growth efficiency, while fecundity directly governs reproductive output and population buildup under field conditions (Pradhan *et al*., 2023; Radhika *et al*., 2023). These parameters are, therefore, central to population modeling, outbreak prediction, and the formulation of stage-specific management interventions.

Despite extensive studies on *Z. cucurbitae*, the information on host-specific biological traits on bitter gourd, particularly for the populations originating from eastern India, remains limited. Inadequate characterization of developmental patterns, morphometric variability, and reproductive potential on this host constrains the development of targeted, ecologically sustainable management strategies. Hence, the present study was aimed to evaluate the developmental duration, morphometry, and reproductive potential of *Z. cucurbitae* on bitter gourd under standardized laboratory conditions using source populations established from maggots collected from infested fruits in Bhubaneswar (Odisha) and Varanasi (Uttar Pradesh). The generated information is expected to improve the understanding of population-level biological activity, develop predictive models of pest outbreaks, and support the development of effective, stage-specific, and ecofriendly IPM programs for cucurbit.

MATERIALS AND METHODS

The present study on the biology of melon fruit fly, *Zeugodacus cucurbitae* Coquillett was conducted at the Department of Entomology, College of Agriculture, OUAT, Bhubaneswar and the Division of Crop Protection, ICAR- IIVR, Varanasi during *Kharif* seasons of 2023 and 2024, respectively.

Rearing of Zeugodacus cucurbitae

Bitter gourd (*Momordica charantia*) fruits naturally infested with maggots of *Z. cucurbitae* were collected from the experimental field (untreated soil) of OUAT, Bhubaneswar, Odisha and IIVR, Varanasi, Uttar Pradesh during *Kharif* 2023 and 2024, respectively. The maggots of *Z. cucurbitae* were reared as per the method described by Samalo *et al*. (1991), with appropriate modifications to suit laboratory conditions. The maggots were gently removed from the fruits and transferred to petri-dishes containing a moist layer of sand to maintain adequate humidity. The sand surface was covered with tissue paper to suppress fungal growth. Fresh tender slices of bitter gourd were placed on the tissue paper, and the petri dishes were kept inside a rearing cage to support larval growth. To ensure uninterrupted feeding, fresh bitter gourd slices were replaced at 48 h time intervals. The mature maggots were allowed to pupate within the sand medium. The presence of white tissue paper facilitated easy identification of pupae against sand background. After pupation, pupae were carefully collected and transferred to separate containers containing sand and subsequently placed in rearing cage for adult emergence. Newly emerged adults were gently collected using insect collection tubes within the cage to prevent injury. The adults were sexed, paired, and transferred to a wooden oviposition cage (45 cm × 45 cm × 45 cm). As the flies tended to remain inside the collection tubes immediately after capture, the tubes were kept inside the cage until the insects acclimatized, thereby minimizing the escape and mortality. Adult flies were provided with cotton pads soaked in a 20% honey solution as a food source. For egg laying, fresh tender bitter gourds were placed inside the oviposition cage. Upon egg hatch, the emerging maggot were transferred back to the rearing cage, where they continued development and pupated in the sand substrate, thus maintaining a continuous laboratory culture of *Z. cucurbitae*.

Experimental setup and morphometric observations

The study was carried out under prevailing laboratory conditions and uniform environmental conditions *viz*., room temperature, relative humidity, photo-period (25±2°C, 65±5% RH,12:12 h light: dark). The rearing conditions were regularly monitored to ensure uniformity during experimentation. About 20 observations were taken to facilitate reliable documentation of biological attributes of *Z. cucurbitae*. Systematic observations were noted on the duration across all life stages including egg, maggot, pupal, and adult stages to elucidate the complete life cycle of insect. Detailed morphometric measurements (length and width/wing span) were noted at each stage to assess growth patterns and size variations throughout the development using a COSLAB trinocular microscope (ZSM-115) fitted with COSLAB software. Egg and pupa lengths were measured in mm as the distance in mm from the anterior to the posterior end of the egg or pupal case, respectively, while width was recorded as the maximum dimension perpendicular to the length. Maggot length was measured in mm as the distance from the head capsule to the anal segment, while width taken as maximum breadth of the thoracic region. In adults, wingspan was measured as the distance between fully extended wings, and body length as distance from the head to the tip of abdomen. Adult reproductive parameters, including fecundity and longevity were also evaluated. The male-to-female sex ratio of emerged adults was calculated to assess population structure and reproductive potential under both the experimental conditions. These biological parameters provide essential baseline information on the developmental and reproductive biology of *Z. cucurbitae*.

Statistical analysis

As the study involved no treatments and was conducted to document the biological attributes of *Z. cucurbitae*, the data were analyzed using descriptive statistics. For each biological parameter, the measurements were taken from 20 independently reared individuals (n = 20) for each life stage (egg, larva, pupa, and adult) from Bhubaneswar and Varanasi separately. Each individual insect served as one experimental unit, and all observations were made under identical laboratory conditions. The results were expressed as mean ± standard deviation. No inferential statistical tests were applied, as the objective was to characterize baseline biological traits under standardized laboratory conditions.

RESULTS AND DISCUSSION

The present study examined the biological parameters *viz*., developmental duration, adult longevity, morphometric traits, and female fecundity of fruit fly (*Zeugodacus cucurbitae*) on bitter gourd under laboratory conditions. The external morphology of *Z. cucurbitae* at successive developmental stages was in close conformity with the earlier reported descriptive characteristics (Laskar, 2013; Bhat, 2023; Chaudhary *et al*., 2025). Eggs were elongated, smooth and slightly curved, creamy white at oviposition, gradually became translucent prior to hatching. They were typically deposited singly or in small clusters beneath fruit epidermis, rendering them inconspicuous to the naked eyes (Fig. 1a). Freshly hatched maggots were apodous, slender, and pale white, actively burrowing into the fruit tissue shortly after emergence (Fig. 1b). As maggot development progressed through successive instars, maggots became stout and more robust, with anterior end tapering but blunt at posterior end

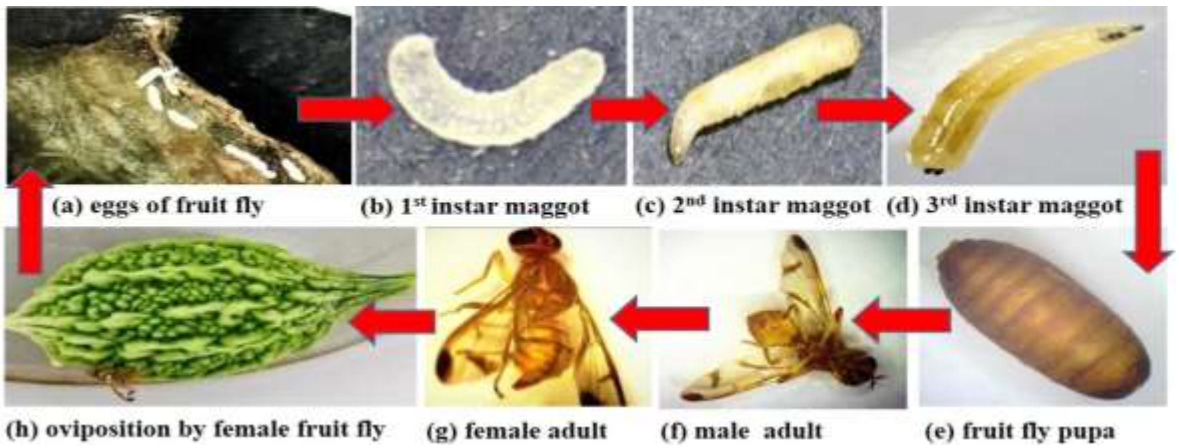

Fig. 1: Life cycle of *Zeugodacus cucurbitae;* a) eggs of fruit fly, b) 1st instar maggot, c) 2nd instar maggot, d) 3rd instar maggot, e) fruit fly pupa, f) male adult, g) female adult, and h) oviposition by female fruit fly

(Fig. 1c). Fully developed 3rd instar maggot exhibited a glossy creamy-white body with distinct segmental demarcation and prominent mouth hooks adapted for rasping host tissues (Fig, 1d).

The pre-pupal stage was characterized by cessation of feeding and contraction of larval body, accompanied by gradual hardening and shortening. Pupae were typical coarctate type, oval to barrel-shaped, initially light brown and later turned dark brown with advanced development. The pupal surface appeared smooth and rigid, offering protection during metamorphosis (Dhillon *et al*., 2005a; Chaudhary *et al*., 2025). Adults emerged as moderately sized tephritid flies with a predominantly yellowish-brown body (Fig. 1f, g). Newly emerged flies were soft-bodied and pale, attaining full pigmentation within a few hours. The thorax bore characteristic markings, while wings were hyaline with distinct brown bands and spots forming species-specific patterns. Females were easily distinguished by their comparatively larger body size and the presence of a well-developed, pointed ovipositor adapted for fruit puncturing, whereas males were relatively smaller with slender abdomen. The adult morphological traits provide reliable diagnostic features for species identification and are consistent with earlier descriptions of *Z. cucurbitae* on cucurbits (Bhat, 2023; Dhillon *et al*., 2005a).

Developmental duration and life cycle dynamics

The duration of developmental stages of *Z. cucurbitae* showed slight differences between the Bhubaneswar and Varanasi (Table 1). The embryonic period lasted 1.30 ± 0.38 days at Bhubaneswar and 1.55 ± 0.42 days at Varanasi. Maggot development was 6.60 days at Bhubaneswar and 6.75 days at Varanasi. Pupal duration was 6.50 ± 0.51 days at Bhubaneswar and 6.95 ± 0.74 days at Varanasi. Adult longevity was 23.95 ± 2.94 and 29.15 ± 3.77 days for males and females, respectively, at Bhubaneswar, compared to 25.25 ± 3.86 and 31.55 ± 4.07 days at Varanasi. The oviposition period was 15.15 ± 3.50 days at Bhubaneswar and 16.30 ± 3.71 days at Varanasi. Consequently, the total life-cycle duration was 37.45 ± 3.05 days for males and 41.30 ± 2.32 days for females at Bhubaneswar, and 40.90 ± 1.84 days for males and 45.55 ± 3.06 days for females at Varanasi.

A synthesis of reported biological parameters of *Z. cucurbitae* under standardized laboratory conditions demonstrates notable inter-study variation, with total developmental duration ranging from

Table 1: Duration of developmental stages of *Z. cucurbitae* Coquillett in bitter gourd at OUAT, Bhubaneswar and ICAR-IIVR, Varanasi (India)

Stages	Duration [mean ± SD (days)]	
	Kharif 2023 (Bhubaneswar)	*Kharif* 2024 (Varanasi)
Egg	1.30 ± 0.38	1.55 ± 0.42
Maggot – 1st instar	1.55 ± 0.68	1.50 ± 0.51
- 2nd instar	2.35 ± 0.48	2.60 ± 0.50
- 3rd instar	2.70 ± 0.40	2.65 ± 0.58
Pre-pupa	1.30 ± 0.30	1.17 ± 0.24
Pupa	6.50 ± 0.51	6.95 ± 0.74
Adult - Male	23.95 ± 2.94	25.25 ± 3.86
- Female	29.15 ± 3.77	31.55 ± 4.07
Oviposition	15.15 ± 3.50	16.30 ± 3.71
Total life period – Male	37.45 ± 3.05	40.90 ± 1.84
- Female	41.30 ± 2.32	45.55 ± 3.06

The values in the columns are mean of 20 observations

31.03 ± 0.99 to 40.34 days (Rahaman *et al*., 2015; Ghodekar *et al*., 2025), egg incubation from 1.30 ± 0.38 to 2.01 ± 0.67 days (Laskar, 2013; Bhat *et al*., 2023), and adult longevity spanning ~20 to 38 days (Vigneswaran *et al*., 2016; Chaudhary *et al*., 2025), despite similar controlled rearing regimes (25±2°C and 65±5% RH). This variability underscores the role of inherent population-level differences and carry-over effects from prior environmental conditioning, a phenomenon increasingly recognized in insect developmental ecology.

Morphometric stability and sexual dimorphism

Morphometric observations revealed minimal inter-location variation, indicating structural stability across the populations. Egg dimensions remained uniform (mean; 1.18 mm) and width ranged from 0.25 mm to 0.29 mm. A progressive maggot growth was evident, with 3rd instar maggots measuring 8.05 ± 0.14 mm at Bhubaneswar and 7.92 ± 0.13 mm at Varanasi. Pre-pupal and pupal dimensions were marginally higher in Bhubaneswar population, although the differences were not pronounced. Adult females consistently exceeded males in body size at both the locations, with mean body length of 7.32 ± 0.21 mm at Bhubaneswar and 7.20 ± 0.16 mm at Varanasi, while the corresponding wing spans were 15.10 ± 0.47 mm and 14.94 ± 0.41 mm, respectively (Table 2). This pronounced sexual dimorphism concurs with earlier reports by Mir *et al*. (2014), Adhikari *et al*. (2025) and Choudhary *et al*. (2025) who attributed larger female size to increased reproductive investment, including ovary development and oviposition potential. The slight morphometric variation between locations suggests

Table 2: Morphometrics of developmental stages of *Z. cucurbitae* in bitter gourd at OUAT, Bhubaneswar and ICAR-IIVR, Varanasi (India)

Stages	Morphometrics [mean ± SD (mm)]			
	Kharif 2023 (Bhubaneswar)		*Kharif* 2024 (Varanasi)	
	Length	Width/wingspan	Length	Width/wingspan
Egg	1.19 ± 0.02	0.29 ± 0.01	1.17 ± 0.03	0.25 ± 0.01
1st instar maggot	1.53 ± 0.18	0.31 ± 0.06	1.46 ± 0.16	0.28 ± 0.06
2nd instar maggot	4.00 ± 0.10	1.17 ± 0.10	3.94 ± 0.10	1.03 ± 0.04
3rd instar maggot	8.05 ± 0.14	2.05 ± 0.07	7.92 ± 0.13	2.03 ± 0.07
Pre-pupa	6.50 ± 0.12	2.17 ± 0.10	6.38 ± 0.19	2.14 ± 0.10
Pupa	5.21 ± 0.13	2.46 ± 0.10	5.12 ± 0.11	2.42 ± 0.09
Male adult	6.63 ± 0.17	11.13 ± 0.53	6.52 ± 0.15	10.88 ± 0.47
Female adult	7.32 ± 0.21	15.10 ± 0.47	7.20 ± 0.16	14.94 ± 0.41

Note: Width for egg, maggot, pre-pupa and pupal stage, and Wingspan for adult stage;
The values in column are the mean of 20 observations.

phenotypic plasticity influenced by larval feeding efficiency, host nutritional quality, and pre-laboratory environmental exposure, rather than experimental influences.

Fecundity and sex ratio

Fecundity and sex ratio were remarkably consistent at both the locations, demonstrating the biological robustness of *Z. cucurbitae* (Table 3). Mean fecundity was 80.69 ± 3.38 eggs female^{-1} at Bhubaneswar and 78.86 ± 3.17 eggs female^{-1} at Varanasi. These values closely align with Sowmiya *et al*. (2021) and Ghodekar *et al*. (2025), although they are comparatively lower than the exceptionally high fecundity recorded by Laskar (2013), reflecting population-specific variability. The male: female sex ratio remained slightly male-biased at both locations with ratios of 1.15:1 at Bhubaneswar and 1.24:1 at Varanasi, corroborating earlier findings by Mir *et al*. (2014) and Das *et al*. (2025).

Table 3: Fecundity of female adult and male: female sex ratio of *Z. cucurbitae* n bitter gourd at OUAT Bhubaneswar and ICAR-IIVR Varanasi (India)

Parameters	*Kharif* 2023 (Bhubaneswar)	*Kharif* 2024 (Varanasi)
Fecundity (No. of eggs female^{-1})	80.69 ± 3.38	78.86 ± 3.17
Sex ratio (male: female)	1.15: 1.00	1.24: 1.00

Each value is mean of 20 observations

Despite being maintained under identical laboratory conditions (25 ± 2 °C and 65 ± 5% relative humidity), the two populations exhibited noticeable differences in developmental duration, adult longevity, morphometric traits, and female fecundity. As experimental conditions were uniform, these variations are more plausibly attributed to inherent differences associated with population origin, as the maggots were initially collected from distinct field environments (OUAT and IIVR). Such population-specific responses likely represent residual effects of prior field exposure that persist across laboratory generations. Comparable carry-over influences of population history on developmental and reproductive parameters of *Z. cucurbitae* have also been reported under standardized rearing conditions (Gaddanakeri and Rolania, 2020; Sowmiya *et al.*, 2021).

Ecological and applied implications

Understanding the biological performance of *Z. cucurbitae* under controlled conditions provides a critical baseline for interpreting population dynamics and designing effective management strategies. The life-history parameters documented in this study offer valuable insights into host suitability and reproductive potential, which are essential for both laboratory mass rearing and field-level pest management interventions. The biological stability and consistently high reproductive output observed in present study also support the suitability of bitter gourd as a host substrate for laboratory rearing. Bavithra *et al*. (2021) demonstrated that optimized rearing diets significantly enhance pupal recovery, adult emergence, and flight ability, thereby strengthen the prospects for sterile insect technique (SIT) and bait-based management programs. Complementary field level observations by Mohammad *et al*. (2022) and trap-based monitoring studies by Adhikari *et al*. (2025) further illustrate how intrinsic biological traits interact with seasonal dynamics and surveillance strategies to influence population trends.

Recent advances in pest management have showed that several newer chemistries and biopesticides can directly inhibit key biological parameters of fruit flies and other insect pests. Anthranilic diamide insecticides, such as chlorantraniliprole and cyantraniliprole, activate insect ryanodine receptors, leading to disrupted muscle function, delayed development, reduced survival, and altered reproductive output in treated insects, including delayed development and lowered fecundity in model lepidopteran systems, indicating potential for similar impacts on tephritid flies' life-history traits when exposed under field conditions. (Xu *et al*., 2016). Similarly, spinosad, a microbial-derived neurotoxin, has been reported to significantly reduce fruit fly infestation and yield loss in cucurbits by inducing high mortality and lowering infestation rates, either alone or in combination with other biocontrol agents (Rahman *et al*., 2019). Botanicals and plant-derived extracts including essential oils, have also shown insecticidal activity against *Bactrocera* species by increasing mortality and repellence, thus potentially affecting feeding and development (Akram *et al*., 2024). In addition, entomopathogenic fungi such as *Beauveria bassiana* have demonstrated considerable virulence against tephritid larvae and adults, causing significant mortality and therefore diminishing population growth potential, and can be effectively integrated with other control agents for improved efficacy (Li *et al*., 2024). Together, these agents affect survival, developmental duration, fecundity, behavior, and infestation levels, underscoring the need for integrated pest management strategies that combine biopesticides and reduced-risk insecticides to target multiple biological parameters of fruit fly populations.

Overall, the present study reaffirms that bitter gourd is a highly suitable host for *Z. cucurbitae*, capable of sustaining rapid development, stable morphometry, and high fecundity. The study further demonstrates that even slight environmental variation carried over into laboratory populations can significantly influence the life-cycle progression, emphasizing the need to integrate climatic history into population prediction models and region-specific integrated pest management strategies.

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Ethical consent statement: This study did not involve human participants or vertebrate animals, therefore, ethical approval and informed consent were not required. All procedures were conducted in accordance with institutional and national guidelines for laboratory research, ensuring responsible practices and minimizing harm to experimental organisms. The study complied with the ethical standards of journal and adhered to the international norms for responsible scientific research.

Author's contributions: SSD carried out execution of research work supported by others, drafted the manuscript, analysed and interpreted the data; and rest all authors contributed in review process, manuscript editing and overall supervision.

Declaration: No generative artificial intelligence (AI) or AI-assisted technologies were used in manuscript preparation, data analysis, and image creation. The manuscript was prepared entirely by the authors, and all content reflects original scholarly work.

REFERENCES

Adhikari, D., Adhikari, S., Dhungana, A. and Acharya, R. 2025. Monitoring fruit fly species in pumpkin field and detection of melon fruit fly *Zeugodacus cucurbitae* from infested cucumber fruits. *Andalasian International Journal of Entomology*, **3**: 97-105.

Akram, W., Hussain, A., Abbas, Q. and Abbas, A. 2024. Insecticidal potential of botanical extracts for management of the oriental fruit fly, *Bactrocera dorsalis* (Diptera: Tephritidae). *The Journal of Basic and Applied Zoology*, **85**: 63. [*https://doi.org/10.1186/s41936-024-00417-2*].

Bavithra, C.M.L., Panduranga, G., Rajesh, A., Reddy, P.K. and Murthy, B.R. 2021. Studies on life history parameters of melon fruit fly. *Andhra Pradesh Journal of Agricultural Sciences*, **7**: 111-117.

Bhardwaj, N., Singh, S.B., Patidar, R. and Jatav, P.K. 2022. Field screening of cucumber (*Cucumis sativus* L.) cultivars against fruit fly (*Bactrocera cucurbitae* Coquillett). *The Pharma Innovation Journal*, **11**: 1711-1713.

Bhat, R.A. 2023. *Studies on Biology and Management of Melon Fruit Fly,* Bactrocera cucurbitae *(Coquillett) on Cucumber.* Ph.D. Thesis, S.K University of Agricultural Sciences and Technology of Kashmir, Srinagar India. [*https://krishikosh.egranth.ac.in/server/api/core/bitstreams/ef947325-3548-4d28-8209-0b98f52bae39/content*].

CABI. 2018. *Zeugodacus cucurbitae*. *Distribution Map of Plant Pests*. *Map 64 (4th Revision)*. CABI, Kew, UK. [*https://doi.org/10.1079/DMPP/20173373945*].

Chaudhary, K.V., Patel, S.R. and Kumar, A. 2025. Biology of melon fruit fly, *Bactrocera cucurbitae* (Coquillett), on cucumber. *Indian Journal of Entomology*, **87**: 417-420.

Das, K., Yadav, S. and Saini, V. 2025. Effect of temperature on the development and life cycle of the melon fruit fly *(Zeugodacus cucurbitae)*. **In**: *2nd International Conference on Entomology*. 19-21 May, 2025. IECE Conference Online, MDPI, Basel, Switzerland.

De Meyer, M., Delatte, H., Mwatawala, M., Quilici, S., Vayssières, J.F. and Virgilio, M. 2015. A review of the current knowledge on *Zeugodacus cucurbitae* (Coquillett) (Diptera: Tephritidae) in Africa, with a list of species included in *Zeugodacus*. *ZooKeys*, **540**: 539-557.

Dhillon, M.K., Singh, R., Naresh, J.S. and Sharma, H.C. 2005a. The melon fruit fly *Bactrocera cucurbitae*: A review of its biology and management. *Journal of Insect Science*, **5**: 40. [*https://doi.org/10.1093/jis/5.1.40*].

Dhillon, M.K., Singh, R., Naresh, J.S. and Sharma, N.K. 2005b. Influence of physicochemical traits of bitter gourd (*Momordica charantia* L.) on larval density and resistance to melon fruit fly, *Bactrocera cucurbitae* (Coquillett). *Journal of Applied Entomology*, **129**: 393-399. [*https://doi.org/10.1111/j.1439-0418.2005.00911.x*].

EPPO. 2024. *Zeugodacus cucurbitae* (*Dacus cucurbitae*) *Datasheet*. European and Mediterranean Plant Protection Organization, Paris, France. [*https://gd.eppo.int/taxon/DACUCU*].

Gaddanakeri, S. and Rolania, K. 2020. Biology and morphometrics of melon fruit fly, *Bactrocera cucurbitae* Coquillett on bitter gourd (*Momordica charantia* L.). *Journal of Entomology and Zoology Studies*, **8**: 994-998.

Ghodekar, K.S., Yendrembam, K.D., Sonawane, V.K., Longkumer, I.Y. and Ibrahim, M.M. 2025. Biology and development of the melon fruit fly, *Zeugodacus cucurbitae* (Coquillett), on various cucurbit hosts. *New Zealand Journal of Crop and Horticultural Science*, **53**(5): 2603-2618.

Hadapad, A.B., Shettigar, S.K. and Hire, R.S. 2019. Bacterial communities in the gut of wild and mass-reared *Zeugodacus cucurbitae* and *Bactrocera dorsalis* revealed by metagenomic sequencing. *BMC Microbiology*, **19**: 282. [*https://doi.org/10.1186/s12866-019-1647-8*].

Jang, E.B., Carvalho, L.A.F.N., Chen, C.C. and Siderhurst, M.S. 2017. Cucumber lure trapping of *Zeugodacus cucurbitae* (Diptera: Tephritidae) in Hawaii and Taiwan. *Journal of Economic Entomology*, **110**: 201-207.

Kayattukandy Balan, R., George, S., Pines, G., Li, D., Gunawardana, D. and Puthigae, S. 2025. Species-specific real-time PCR assay for rapid identification of *Zeugodacus cucurbitae* (Coquillett). *Insects*, **16**: 818. [*https://doi.org/10.3390/insects16080818*].

Ladania, M.S. 2008. Physiological disorders and their management. pp. 451-463. **In**: *Citrus Fruit: Biology*, *Technology and Evaluation*. Elsevier Academic Press, Cambridge, UK,

Laskar, N. 2013. Biology and biometrics of melon fruit fly, *Bactrocera cucurbitae* (Coquillett). *Current Biotica*, **7**: 51-59.

Leblanc, L. 2022. The dacine fruit flies (Diptera: Tephritidae: Dacini) of Oceania. *Insecta Mundi*, **948**: 1-167.

Li, X.L., Zhang, J.J., Li, D.D., Cai, X.Y., Qi, Y.X. and Lu, Y.Y. 2024. Toxicity of *Beauveria bassiana* to *Bactrocera dorsalis*. *Frontiers in Microbiology*, **15**: 1362089. [*https://doi.org/10.3389/fmicb.2024.1362089*].

Mir, S.H., Dar, S.A., Mir, M. and Ahmed, S.B. 2014. Biology of *Bactrocera cucurbitae* on cucumber. *Florida Entomologist*, **97**: 753-758.

Mohammad, A.K.H. 2022. Biological and control study of the cucurbit fruit fly, *Dacus ciliatus* (Loew). *Biochemical and Cellular Archives*, **22**: 2923-2930.

Nithya, K., Kavitha, Z., Shanthi, M., Vijayaraghavan, C. and Swarnalatha, K. 2025. Management of melon fruit fly *Zeugodacus cucurbitae*. *Uttar Pradesh Journal of Zoology*, **46**: 55-64.

Pradhan, S., Karuppannasamy, A., Sujatha, P., Nagaraja, B., Bynakal, S., Riegler, M., *et al.*, 2023. Comparative analyses of age-stage, two-sex life table and host preference of *Zeugodacus cucurbitae* (Coquillett) (Diptera: Tephritidae) on different hosts. *Animal Biology*, **73**: 341-361.

Radhika, S.D.B., Sonkamble, M.M. and Udavant, R.N. 2023. Morphometric study of melon fruit fly (*Bactrocera cucurbitae*). *The Pharma Innovation Journal*, **12**: 702-706.

Rahman, M.M., Howlader, M.T.H., Islam, K.S. and Morshed, M.N. 2019. Efficacy of biopesticides against cucurbit fruit fly. *Journal of the Bangladesh Agricultural University*, **17**: 483-489.

Samalo, A.P., Beshra, R.C. and Satpathy, C.R. 1991. Comparative biology of the melon fruit fly, *Dacus cucurbitae* Coq. *Orissa Journal of Agricultural Research*, **4**: 1-5.

Sarada, G., Manjula, K., Muralikrishna, T., Gopal, K. and Reddy, B.R. 2022. Management of fruit flies infesting muskmelon through eco-friendly modules. *Pest Management in Horticultural Ecosystems*, **28**: 88-92.

Sharma, D.K., Manzoor, U. and Kumar, R. 2025. Spatiotemporal damage distribution of melon fly. *International Journal of Entomology Research*, **10**: 72-75.

Sowmiya, L., Chandrasekaran, M., Soundararajan, R.P. and Ramesh, D. 2021. Biology and morphometry of melon fruit fly. *Journal of Entomology and Zoology Studies*, **9**: 353-357.

Toyzhigitova, B., Yskak, S., Łozowicka, B., Kaczyński, P., Dinasilov, A. and Zhunisbay, R., *et al.*, 2019. Biological and chemical protection of melon crops. *Journal of Plant Diseases and Protection*, **126**: 359-366.

Vigneswaran, S., Rani, W.B. and Kalyanasundaram, M. 2016. Biology and morphometric studies of *Bactrocera cucurbitae* Coquillett (Diptera: Tephritidae) on different *Coccinia indica* Wight and Arn. cultivars. *Indian Journal of Agricultural Sciences*, **86**: 938-941.

Xu, C., Zhang, Z., Cui, K., Zhao, Y., Han, J. and Liu, F., *et al.*, 2016. Effects of sublethal concentrations of cyantraniliprole. *Plos ONE*, **11**: e0156555. [*https://doi.org/10.1371/journal.pone.0156555*].