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Kamil Kabir Khanzada
Department of Entomology, Sindh Agricuture University Tandojam, Sindh, Pakistan.

Bhai Khan Solangi
Department of Entomology, Sindh Agricuture University Tandojam, Sindh, Pakistan

Abid Ali Soomro
Department of Entomology, Sindh Agricuture University Tandojam, Sindh, Pakistan

Fida Hussain Magsi
Department of Entomology, Sindh Agricuture University Tandojam, Sindh, Pakistan

Maqsood Ahmed Chandio
Department of Entomology, Sindh Agricuture University Tandojam, Sindh, Pakistan

Babar Hussain Chang
Department of Entomology, Sindh Agricuture University Tandojam, Sindh, Pakistan

Razique Ali Nahiyoon
Department of Entomology, Sindh Agricuture University Tandojam, Sindh, Pakistan

Syeda Maira Jaffery
Department of Entomology, Sindh Agricuture University Tandojam, Sindh, Pakistan

Correspondence
Kamil Kabir Khanzada
Department of Entomology, Sindh Agricuture University Tandojam, Sindh, Pakistan.

Preference of *Dirhinus giffardii* on the pupae of *Bactrocera zonata* and *Bactrocera cucurbitae* at variable temperature

Kamil Kabir Khanzada, Bhai Khan Solangi, Abid Ali Soomro, Fida Hussain Magsi, Maqsood Ahmed Chandio, Babar Hussain Chang, Razique Ali Nahiyoon and Syeda Maira Jaffery

Abstract
The particular study was conducted to examine the preference of *D. giffardii* on the pupae of *B. zonata* (Saunders) and *B. cucurbitae* (Coquillett) at different temperatures. The experiment was conducted at Dipterian Research Laboratory, Department of Entomology, Faculty of Crop Protection, and Sindh Agriculture University Tandojam during 2015-2016. The Research was carried out at five constant temperatures (15ºC, 20ºC, 25ºC, 30ºC and 35ºC). The results revealed that the maximum emergence percentage of parasitoid female adults was founded on *B. zonata* pupae at 25ºC 22.6±0.82, followed by 20ºC 18.0±0.64, 30ºC 17.4±0.51, 35ºC 14.8±0.97, whereas, minimum emergence was observed at 15ºC 11.8± 0.38. For male adults, the maximum emergence percentage was 18.0±0.71 at 25ºC and the minimum emergence was recorded at 15ºC 8.80±0.59. The *B. cucurbitae* showed the highest emergence percentage for both, female and male adults' at 25ºC which was 19.6±1.17 and 15.4±0.82 respectively. The minimum emergence percentage was recorded at 15ºC for both sexes. The results determined that *D. giffardii* prefer *B. zonata* as compared to *B. cucurbitae*. Furthermore, the analyzed data showed significant difference between different treatments (P<0.05). On the basis of above results it can be concluded that the optimum temperature for mass rearing of *D. giffardii* is 25ºC while the more suitable host is *B. zonata.*

Keywords: *B. zonata, B. cucurbitae, D. giffardii,* emergence, temperature, incubator

1. Introduction
The fruit flies (Diptera: Tephritidae) are the most economically and key pests of many soft fruits all over the world (White and Elson-Harris, 1992) [9]. The Peach fruit fly *Bactrocera zonata* (Saunders), are very native to south-east Asia, over 50 types of species all are responsible to
attack a wide variety of soft fruits as well as crops which including guava, mango, peach, apricot, fig and citrus (White & Elson-Harris, 1992) [9]. The eleven species of fruit flies are also obtained from Pakistan and most distinguished are *Bactrocera zonata, Bactrocera cucurbitae, Bactrocera dorsalis, Myiopardalis pardalina, Carpomiy aincompleta, C. vesuviana, Dacus ferrugincus* and *D. diversus*. While the common fruits apple, ber, guava, mango, musk, melon and bitter gourd hosts of fruit flies recorded in Pakistan (Ahmad *et al*., 2010) [1]. The cucurbit fruit fly *Bactrocera cucurbitae* (Coquillett) is a one of the most destructive pest of different types of cucurbit vegetables in over the entire world, the crop losses was often recorded more than 60 percent and cucurbit fly is distributed in temperate, tropical, and sub-tropical regions over all the world. There are two types of specie was found commonly *Bactrocera cucurbitae* and *Bactrocera caudatus* (Alam *et al*., 1964) [2].
The classical biological control (agents) of insect pests reported the introduction and establishment of new natural enemies (i.e., prey, parasitoids, and pathogens) for control the resident pests (Van Driesche and Bellows, 1993) [5]. *Dirhinus giffardii* (Silvestri) is local from West Africa, where it is distinctive host of *C. capitata*. It has been brought into more than twenty nations, chiefly in the aggressive and Central American locales. It was introduced from Hawaii and Italy 1912 to 1913 to control the *C. capitata* and the olive fruit fly *Bactrocera oleae*, respectively, while it trans-dispatched Hawaii to Israel to control of *C. capitata* (Wang and Messing, 2004a) [7]. The pupal parasitoid *Dirhinus giffardii* is look for hosts by stroll over

the earth surface. If female adult experiences a host, the female analyzed the host with help of.her antennae to feel, and drill into the shell of the host puparium (exoskeleton of the flies' last larval stage) and it have also ability to laying egg into the space between the host pupae and the puparium but in that condition the host is suitable. Laying an egg by a female adult of parasitoid *Dirhinus giffardii* can take-up to 30 min (Wang and Messing, 2004) [8]. Although the use of classical biological control against endemic and exotic agricultural insect pests still of increasing interest, the biology of certain bio-control agents from the parasitoids is not fully studied. But the *Dirhinus giffardii* was recorded as a generalist pupal ecto-parasitoid inside pupariaum from the Mediterranean fruit fly, (*Ceratitis capitata* Wiedemann) on the other tephritid species. Such as, *D. giffardii* acted as a hyper parasitoid on the primary of braconid larval pupal parasitoids; *Diacasmimor phacraussii* filled away and *Psyttalia concolor* (Szepligeti) in *C. capitata* and *Bactrocera latifrons* (Hendel) (Podoler and Mazor, 1981) [4]. To avoid insecticides hazard bio-control in found to be a best substitute to suppress insect pest population in fruits and vegetables crops. Now a days, biological control methods offer one of the most capable, naturally sound, and maintainable mechanisms against arthropod pests (van and Hoddle, 2008). Parasitoids are extremely responsible to changes in environmental conditions and dependent on a series of adaptations to the ecology and physiology of their hosts and host plants for survival environmental conditions. The adaptation of parasitoids at low temperatures is like to individuals of most ectotherms, but these adaptations are embarrassed by the response of their hosts. The life history of an insect trait is affected by a coldest exposure, and extreme temperatures can be reducing endosymbiont populations inside a parasitoid, finally eliminating populations of endosymbiosis which are susceptible to the highest temperatures. Although *D. giffardii* gained such as important role in control programs of fruit flies worldwide, only few of its biological aspects have been documented. Thus, the present study aims to shed more light on the biology of this parasitoid when parasitizing pupae of *B. zonata* in the laboratory (Hance *et al*., 2006) [3].

2. Materials and Methods

Place of Work

The present research work was conducted on "Preference of *Dirhinus giffardii* on the pupae of *Bactrocera zonata* and *Bactrocera cucurbitae* at different temperatures" in Dipterian Research Laboratory, Department of Entomology, Faculty of Crop Protection, Sindh Agriculture University Tando jam during 2015-2016.

The pupal parasitoid *Dirhinus giffardii* and pupae of two fruit flies species *Bactrocera zonata* and *Bactrocera cucurbitae* were obtained from Dipterian Research laboratory. The fruit flies *Bactrocera zonata* and *Bactrocera cucurbitae* were reared on mass cultured sugar, water and protein hydrohysate. Under the pupae popout days, the trays were kept in population substrate in the large trays to collect the pupae. A sample of 48 hours old 250 pupae of each fruit fly *Bactrocera zonata* and *Bactrocera cucurbitae* was kept in Jars. Each Jar was containing 50 un-parasitized pupae of both species *Bactrocera zonata* and *Bactrocera cucurbitae* along with five pairs *Dirhinus giffardii*. Five treatments i-e T1=15ºC, T2=20ºC, T3=25ºC, T4=30ºC and T5=35ºC will have 5 replications was Carried out in the incubators each equipped with two 20 watt and fluorescent lights and set at a 14:10 L/D cycle. Test temperatures ranged from 15ºC to 35ºC increments. Fluctuation at each temperature was 1ºC. The jars were placed in incubators for 48 hours for parasitized the pupae

3. Results

The present study was conducted on Preference of *Dirhinus giffardii* on the pupae of *Bactrocera zonata* (Saunders) and *Bactrocera cucurbitae* at different temperatures. To observe the host preference, Emergence percentage, and impact of different temperatures on emergence % age of *Dirhinus giffardii* at 48 hours old pupae of both species

Host preference of pupal parasitoid, *Dirhinus giffardii*

The data of Table 1 showed that the maximum emergence percentage of adults female was recorded on *Bactrocera zonata* at optimum temperatures 25ºC (22.6±0.81), followed by 20ºC (18.0±0.63), 30ºC (17.4±0.50), 35ºC (14.8±0.96), while the minimum emergence was recorded at temperature 15ºC (11.8± 0.37). While the maximum male adults emergence was obtained at 25ºC (18.0±0.70), followed by 20ºC (14.4±0.74), 30ºC (13.6±0.67), 35ºC (11.4±0.40), and minimum emergence was recorded at lowest temperature 15ºC (8.80±0.58). Whereas the highest percentage of adults (81%) at 25ºC and lowest (41%) at 15ºC. While the overall pupal parasitoid *Dirhinus giffardii* emergence % age at temperatures 15ºC (20.6±0.92), 20ºC (32.40±1.07), 25ºC (40.6±1.28), 30ºC (31.0±1.14) and 35ºC (26.2±1.28). It was further shows that maximum emergence of adults *Dirhinus giffardii* male and female was obtained at 25ºC while the minimum emergence was obtained at 15ºC. The female emergence was higher compared to male adults at 25ºC, and lowest was found at 15ºC. The analysis of data at different temperatures emergence % age was found significant (P>0.05).

Table 1: Preference of *Dirhinus giffardii* on the pupae of *Bactrocera zonata* at different temperatures

Temperature (ºC)	Male	Female	Overall parasitoid emergence
T_1 15ºC	8.80 ± 0.58d	11.8 ± 0.37d	20.6 ± 0.92d
T_2 20ºC	14.4 ± 0.74b	18.0 ± 0.63b	32.40 ± 1.07b
T_3 25ºC	18.0 ± 0.70a	22.6 ± 0.81a	40.6 ± 1.28a
T_4 30ºC	13.6 ± 0.67b	17.4 ± 0.50b	31.0 ± 1.14b
T_5 35ºC	11.4 ± 0.40c	14.8 ± 0.96c	26.2 ± 1.28c
Total Average:	13.15	16.92	32.55

The data of Table 2 showed that in this specie the maximum emergence percentage of adults male was recorded on *Bactrocera cucurbitae* at optimum temperature 25ºC (15.4±0.81), followed by 20ºC (13.2±1.24), 30ºC (10.2±0.86),

35ºC (9.40±0.92), and minimum emergence was recorded at lowest temperature 15ºC (7.60±0.24). And the highest female adults emergence was obtained at 25ºC (19.6±1.16) which followed by 20ºC (16.6±1.02) and there is a little difference emergence % between at the temperature 30ºC (13.8±0.73), to 35ºC (13.4±0.50), while the minimum emergence was recorded at temperature 15ºC (11.8±1.07). Whereas the highest percentage of adults (70%) at 25ºC and lowest (38%) at 15ºC. This table is also indicated that there was same emergence % age of adults' female pupal parasitoid *Dirhinus giffardii* on *Bactrocera zonata* (11.8±0.37), and *Bactrocera cucurbitae* (11.8±1.07) at temperature 15ºC. It was further shows that maximum emergence of male and female *Bactrocera cucurbitae* was obtained at 25 ºC while the minimum emergence was obtained at 15 ºC. And female adults on Bactrocera *cucurbitae* emergence were higher compared to male adult *at* 25 ºC. At all temperatures ranges females live longer than males to complete its development time, the overall pupal parasitoid emergence % age at temperature 15 ºC (19.4±1.20), 20 ºC (29.8±2.20), 25 ºC (35.0±1.92), 30 ºC (24.4±1.41) and 35 ºC (22.8±1.25). The analysis of data for better emergence % was found at different temperatures significant (P>0.05)

Table 2: Preference of *Dirhinus giffardii* on the pupae of *Bactrocera cucurbitae* at different temperatures

Temperature (ºC)	Male	Female	Overall parasitoid emergence
T_1 15 ºC	7.60 ± 0.24c	11.8 ± 1.07	19.4 ± 1.20c
T_2 20 ºC	13.2 ± 1.24a	16.6 ± 1.02b	29.8 ± 2.20d
T_3 25 ºC	15.4 ± 0.81a	19.6 ± 1.16a	35.0 ± 1.92a
T_4 30 ºC	10.2 ± 0.86b	13.8 ± 0.73c	24.4 ± 1.41c
T_5 35 ºC	9.40 ± 0.92bc	13.4 ± 0.50c	22.8 ± 1.25c
Total Average:	11.16	15.04	26.28

4. Discussion

The results of present study described there is five different Test temperatures ranged from 15ºC to 35ºC increments Fluctuation at each temperature was 1ºC. It is indicated that the maximum and minimum emergence percentage of male and female adult's pupal parasitoid *Dirhinus giffardii* was recorded on *Bactrocera zonata* and *Bactrocera cucucrbitae* at same above temperature 25ºC. While the lowest average percentage of *B. zonata* and *B. cucurbitae* female adults (20.6±0.92), (19.4±1.20), and male (8.80±0.58), (7.60±0.24), are compared to one another at 15ºC. However the results further showed that the highest mortality of pupal parasitoid occurred in at cold temperature 15ºC, when the temperature increased the emergence % become increased. On the other hand there was negative relationship between number of emerged adults (females and males) and incubation period for each tested temperatures. And the overall pupal parasitoid highest and lowest emergence percentage *B. zonata* (40.6±1.28), (20.6±0.92), *B. cucurbitae* (35.0±1.92), (19.4±1.20). This research work also indicated that the female adults are more emerged than male for all tested temperatures and within all the periods. On the other hand maximum adults (males and females) *B. zonata* (81%) and *B. cucurbitae* (70%) at 25ºC, it means the pupal parasitoid *D. giffardii* is more prefer *Bactrocera zonata* as compared to *Bactrocera cucurbitae*.

Samira *et al.* (2006) investigated the result of the six constant temperatures on the longevity as well as developmental time of parasitoid at 15±0.5, 20±0.5, 25±0.5, 27±0.5, 30±0.5, and (33±0.05ºC) with relative humidity 60-70%. When temperature gradually increased the developmental rate also increased. At all temperature ranges females live longer than males to complete its developmental time. The hatching from egg till adult emergence it last 244 degree days beyond 11.9 ºC thermal threshold jointly in male and female.

5. Conclusion

The highest emergence percentage was obtained at 25ºC on *B. zonata* and *B. cucurbitae*, whereas lowest at 15ºC. The maximum emergence of adults female was obtained as compare to male parasitoid on both species. The minimum emergence % age of adults (male and female) was recorded on *B. cucurbitae* as compared to *B. zonata*.

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