Pakistan Entomologist

Journal homepage: www.pakentomol.com

HOST PREFERENCE OF *BACTROCERA* FLIES SPECIES (DIPTERA: TEPHRITIDAE) AND PARASITISM POTENTIAL OF *DIRHINUS GIFFARDII* AND *PACHYCROPOIDEUS VINDEMMIAE)* UNDER LABORATORY CONDITIONS

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ARTICLE INFORMATION

Received: January 25, 2017
Received in revised form: June 07, 2017
Accepted: June 16, 2017

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ABSTRACT

Fruit flies are highly detrimental pests of fruits, vegetables and responsible for large economic losses globally. During study, the food preference and parasitism rate of five *Bactrocera* species (*zonata, cucurbitae, dorsalis, oleae* and *correcta*) by *two parasitoids (Dirhinus giffardi* and *Pachycropoideus vindemmiae*) were investigated. These species were collected from five geographically distant locations (about 300–500km temperature gradient) from Pakistan Insect population was raised in controlled conditions on natural and artificial diets. Food preference data sets showed that guava and bitter gourd were the most preferred food for all *Bactrocera* species however *B. cucurbitae* (citrus, pumpkin and cucumber), *B. dorsalis* (mango and cucumber) and *B. oleae* (olives) revealed furthermost preference than other fruits and vegetables. Parasitism of *D. giffardii* on pupae of *B. dorsalis, B. cucurbitae, B. zonata, B. oleae and B. correcta* was 18%, 35%, 37%, 42% and 54% whereas *P. vindemmiae* showed 28%, 34%, 40%, 38% and 47% respectively. Statistically it was analysed that the rate of parasitism of *D. giffardii* was maximum for pupae of *B. oleae* and *B. correcta* and the *P. vindemmiae* exhibited on *B. zonata* and *B. correcta.* The rate of parasitism of both parasitoids was maximum on 2-4 days old pupae. Therefore, it can be concluded that the pupal parasitoids *D. giffardii* and *P. vindemmiae* can be effective biocontrol tool for integration in pest management of five species of *Bactrocera* fruit flies.

Keywords: *Bactrocera* fruit flies, Host preference, *Dirhinus giffardii*, *Pachycrepoideus vindemmiae,* Parasitism

INTRODUCTION

Fruit flies (Diptera: Tephritidae) are very common insect pests of economic importance in tropical, subtropical and several temperate regions of world (Metcalf and Metcalf, 1992; De Meyer *et al*., 2010). The cosmopolitan nature of fruit fly species pinnacles their international importance in sustainable fruit and vegetable production as well as trade issues. Most of the species of fruit flies are polyphagous in nature and thus damage a wide range of fruits and vegetables (Joomaye *et al*., 2000; Rauf *et al*., 2013).

There are 5,000 documented species in Tephritidae family under 6 subfamilies and 500 genera throughout the world (White and Elson-Harris, 1992; Uchoa and Nicacio, 2010). About 70 species of fruit flies are considered important agricultural pests on different vegetables and fruits of tropical and subtropical regions (White and Elson-Harris,1992; Ni *et al*, 2012). The infestation of these fruit flies causes billions of US$ annually (Dowell and Wange, 1986). Therefore, billions of dollars of agriculture commodity are lost due to these pests every year worldwide (Stonehouse *et al*., 1998).

Biological control of insect pests mainly applies the predacious and parasitic natural enemies and has played an essential role in ecosystem conservation (Van *et al*., 2008). *D. giffardii* has been recorded in more than 20 countries in the world to control the Dipteran pests (Noyes, 2001). Biological control through different parasitoids is an effective, environmentally sustainable and safe approach for the pest management which concerned with releases of the predictable enemies at suitable stage and time in the field. Thus use of parasitoids against infesting fruit flies may be dynamic tool to reduce the usage of pesticides against these

Cite this article as: Rasool, B., M. Rafique, M. Asrar, R. Rasool, M. Adeel, A. Rasul and F. Jabeen, 2017. Host preference of *Bactrocera* flies species (Diptera: Tephritidae) and parasitism potential of *Dirhinus giffardii* and *Pachycropoideus vindemmiae* under laboratory conditions. Pak. Entomol., 39(1):17-21.

economic agricultural pests. Keeping in view the biological control of infesting fruit flies through these pupal parasitoids, *D. giffardi* and *P. vindemmiae* can be used as effective biological control agents (Van *et al*., 2006; Zhao *et al*., 2013). Far-sightedly the present study was designed to study the host preference of fruit flies to evaluate the rate of parasitoids parasitism for these important *Bactrocera* species of Pakistan. The findings from the study will further lead to integrate with other control methods for better pest management programmes.

MATERIALS AND METHODS

Study was carried out to determine the host parasitoid interactions of *Bactrocera* species from five geographically distant localities about (300–500km) from two provinces of Pakistan (Punjab-Faisalabad, Sargodha and Chakwal: Khyber Pakhtunkhwa-Bannu and Peshawar during years 2014-2016 (Fig.1). Different infested fruits and vegetables (guava, mango, citrus, apricot, strawberry, bitter gourd, banana, cucumber, pumpkin and olive) were collected and placed in plastic jars, covered with muslin- cloth for aeration. *Bactrocera zonata*, *B. dorsalis*, *B. cucurbitae, B. correcta* and *B. oleae* were identified on the basis of their morphological characteristics (Jiang *et al*., 2013; Drew *et al*., 2005; White, 2000) and then reared on natural as well as artificial diets (Annexure I). Lab culturing of these species were accomplished on 28± 2ºC temperature and 65±5% relative humidity in Entomology lab of Government College University, Faisalabad, Pakistan.

Different fruits and vegetables (guava, mango, citrus, apricot, strawberry, bitter gourd, banana, cucumber, pumpkin and olive) were offered in different glass cages to these five *Bactrocera* species for host preference studies. Each fruit and vegetable was offered in each cage through progressions of experiments. Females lay eggs in offered fruits and vegetables and after 24 hours these infested fruits were transferred to other glass cages having sand and wheat bran. The emerged full grown larvae dropped into mixture of wheat bran and sand for pupation. Then the mixture of wheat bran and sand was sieved and fresh pupae were collected. The artificial diets for *Bactrocera* species were standardized through series of experiments (Sookar *et al*., 2014) and performed culturing in laboratory conditions. The *D. giffardii* and *P. vindemmiae* were reared in lab on their natural host (pupae of *Bactrocera* species) as well as artificial diet (solution of 30% honey and 70% water). A laboratory colony of *D. giffardii* and *P. vindemmiae* was established from adult wasps that were naturally infesting tephritid fruit flies through standardized methodologies to maintain population. Hundred pupae (one day old) of each *Bactrocera* species were kept in five different glass cages and 10 pairs of *D. giffardii* were released having age of 10 – 12 days in each cage concurrently. After 48 hours the parasitoids were removed from cages and number of infested pupae was counted. Same experiments were performed for 2, 3, 4, 5, 6 and 7 days old pupae of each *Bactrocera* species. Similarly, the experiments were repeated in the second phase with *P. vindemmiae*. Anova and LSD test was performed to get deeper insights and analysis of the datasets (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Parasitism of *Dirhinus giffardii* and *Pachycropoideus vindemmiae* was investigated on five different *Bactrocera* species (*zonata, cucurbitae, dorsalis, oleae and correcta*) for inundative releases of parasitoids as biocontrol agents in sustainable pest management programs. The rearing datasets depicted that guava and bitter gourd were most preferable food for all *Bactrocera* species. However the *B. cucurbitae* also preferred (citrus, pumpkin and cucumber), *B. dorsalis* (mango and cucumber) and *B. oleae* (olives) than other fruits and vegetables (Fig. 2).

During study we steered successions of experiments and difference was observed between rate of parasitism of *D. giffardii* and *P. vindemmiae* (Table 3). The rate of parasitism of *D. giffardii* on pupae of *B. dorsalis, B. cucurbitae, B. zonata, B. oleae and B. correcta* was 18%, 35%, 37%, 42% and 54% respectively (Table 1) while parasitism rate of *P. vindemmiae* on pupae of *Bactrocera dorsalis, B. cucurbitae*, *B. oleae, B. zonata and B. correcta* was 28%, 34%, 38%, 40% and 47% respectively (Table 2). The rate of parasitism of *D. giffardii* (54%) and *P. vindemmiae* (47%) was maximum on *B. correcta* species than other *Bactrocera* species (Fig. 3 and 4).

The rate of parasitism and pupal age datasets showed that parasitism rate of both parasitoids on *B. zonata, B. oleae, B. correcta* and *B. cucurbitae* pupae was professed on 2-4 days old pupae whereas in *B. dorsalis* 3 days old pupae were most preferable though overall results exhibited maximum parasitism rates in 2-4 days old pupae for both parasitoids.

During present course of experiments we studied. 1) host preference of *Bactrocera* species was accomplished on natural diets in lab conditions. 2) maximum parasitism of *Dirhinus giffardii* and *P. vindemmiae* in *Bactrocera* species was observed in *B. correcta, B. olaea* and *B. zonata* than other tested species 3). The relationship of pupal age of *Bactrocera* species and parasitism rate was also investigated and maximum parasitism was observed on 2-4 days old pupae.

Based on successions of experiments on egg laying, larval feeding, pupal quality and adult emergence of these *Bactrocera* species, comparatively better results were found on natural as compared to artificial diets (Shah *et al*., 2007). In natural diets guava and bitter gourd was most preferable food. It may be due to slight differences in the proportion of natural contents, difference in the pattern of digestion, absorption and assimilation of these natural diets that ultimately depends on the peculiar organization of molecules in diet for an insect speculation.

Present studies are the first complete insights of the parasitism of both parasitoids in five *Bactrocera* species of Pakistani arena which is a leading step for previous studies regarding the rate of parasitism of *D. giffardii* on *B. zonata* (Naveed *et al*., 2014). The parasitism rate of both parasitoids might be good score for better control of these fruit flies (Van *et al*., 2006 and Zhao *et al*., 2013).

In the present finding we have evaluated the relationship between the rate of parasitism (*D. giffardii* and *P. vindemmiae*) and pupal age in *Bactrocera zonata*, *B. cucurbitae, B. olaea, B. dorsalis* and *B. correcta*. Exhilaratingly the parasitism on *B. zonata, B. oleae, B. correcta* and *B. cucurbitae* pupae was professed on 2-4 days

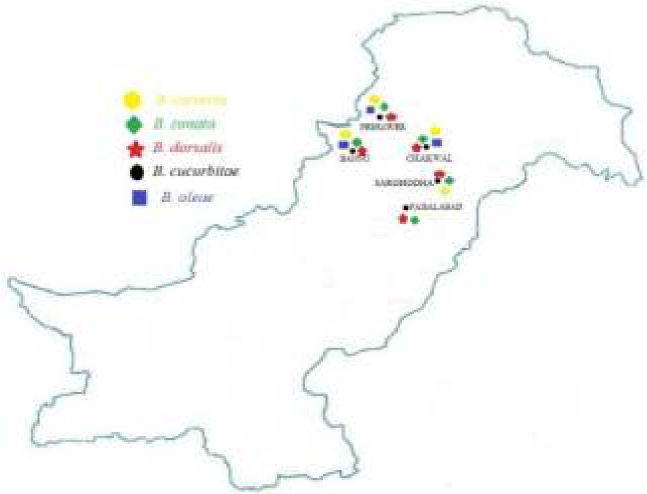

Fig. 1

Selected areas of Pakistan for *Bactrocera* species collection

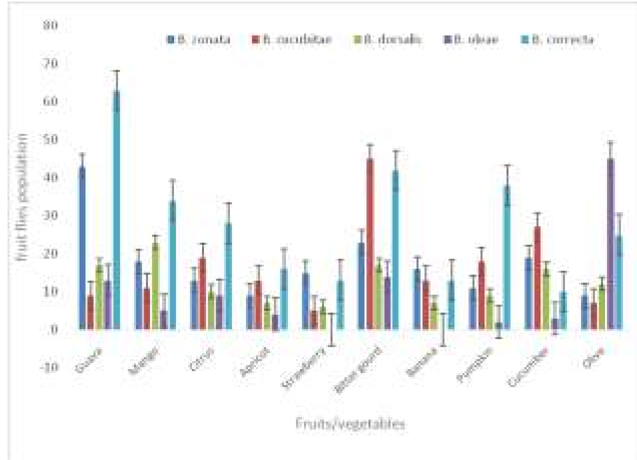

Fig. 2

Means host preference of *Bactrocera species* on different host plants

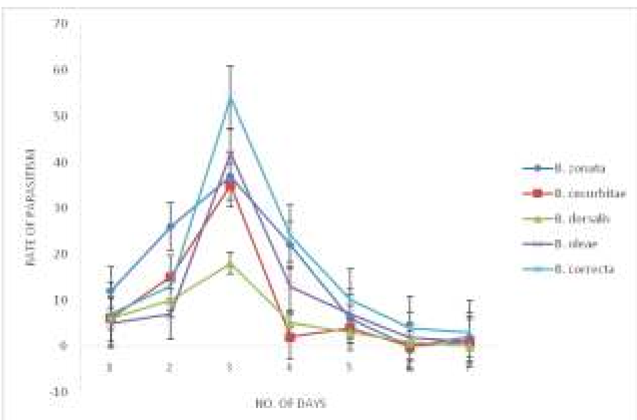

Fig 3

Means rate of parasitism of *D. giffardii* on different aged pupae of *Bactrocera* species *(zonata, cucurbitae*, *dorsalis, oleae* and *correcta*)

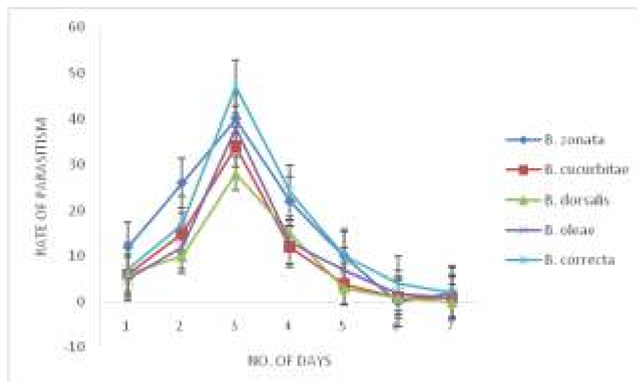

Fig. 4

Means rate of parasitism of *P. vindemmiae* on different aged pupae of *Bactrocera (zonata, cucurbitae*, *dorsalis, oleae* and *correcta)*

old pupae whereas in *B*. *dorsalis* 3 days old pupae were most preferable (Zhao *et al*., 2013) though overall results exhibited maximum parasitism rates in 2-4 days old pupae for both the parasitoids. There is a possibility that the increase of prominent grooves on 4-7 days old pupae of *Bactrocera* species may reduce rate of parasitism of *D. giffardii* and *P. vindemmiae* (Wang and Messing, 2004). Previous studies showed that host pupae of middle age were more preferred for suitable development because increase in age of pupae reduced the nutritional quality of the host pupae (Charnov and Stephens, 1988; Pfannenstiel *et al*., 1996; Ali *et al*., 2016) pragmatically found maximum parasitism after 72 hours.

Therefore, it is concluded that *D. giffardii* and *P. vindemmiae* as pupal parasitoid, can be used as an effective biological control agent for management of these *Bactrocera* species instead of using pesticides and further for integration in sustainable pest management programs.

Table 1

Comparison of means of percent PParasitism of *D. giffardii* on different *Bactrocera* species.

Species	Parasitism Percentage							
	1 day old pupae	2 days old pupae	3 days old pupae	4 days old pupae	5 days old pupae	6 days old pupae	7 days old pupae	Mean ± SE
B. zonata	30	70	90	50	10	10	0	37.14±12.86 B
B. cucurbitae	20	50	80	50	20	20	10	35.71±09.48 B
B. dorsalis	20	20	50	20	10	10	0	18.57±05.95 C
B. olaea	40	70	90	40	30	20	0	41.43±11.43 B
B. correcta	50	90	100	70	50	20	0	54.29±13.60 A
Mean±SE	32.00 ±5.83 CD	60.00 ±11.83 B	82.00 ±8.60 A	46.00 ±8.12 BC	24.00 ±7.48 DE	16.00 ±2.45 EF	2.00 ±2.00 F	

Means sharing similar letter in a row or in a column are statistically non-significant (P>0.05).

Table 2

Comparison of means of percent parasitism of *P. vindemmiae* on different *Bactrocera* species.

	Parasitism Percentage							
Species	1 day old pupae	2 days old pupae	3 days old pupae	4 days old pupae	5 days old pupae	6 days old pupae	7 days old pupae	Mean±SE
B. zonata	20	50	80	50	50	20	10	40.00±9.26 AB
B. cucurbitae	20	40	70	50	30	20	10	34.29±7.82 BC
B. dorsalis	0	30	60	50	30	30	0	28.57±8.57 C
B. olaea	20	50	70	60	40	20	10	38.57±8.57 B
B. correcta	50	50	80	70	40	20	20	47.14±8.65 A
Grand Mean ± SE	22.00 ±8.00 D	44.00 ±4.00 C	72.00 ±3.74 A	56.00 ±4.00 B	38.00 ±3.74 C	22.00 ±2.00 D	10.00 ±3.16 E	

Means sharing similar letter in a row or in a column are statistically non-significant (P>0.05).

Table 3

Comparison of means of percent parasitism of *D. giffardii* and *P. vindemmiae* on different *Bactrocera* species.

	Parasitism Percentage		Mean±SE
Species	*D. giffardii*	*P. vindemmiae*	
B. zonata	37.14	40.00	38.57±1.43 AB
B. cucurbitae	35.71	34.29	35.00±0.71 BC
B. dorsalis	18.57	28.57	23.57±5.00 C
B. olaea	41.43	38.57	40.00±1.43 AB
B. correcta	54.29	47.14	50.72±3.58 A
Mean ± SE	37.43±5.74 A	37.71±3.08 A	

Means sharing similar letter in a row or in a column are statistically non-significant (P>0.05

REFERENCES

Ali, S.S., I.A. Rattar, S.S. Ahmed, A. Bukero, H. Rizwana, S. Naz and T.M. Rattar, 2016. Searching ability of pupal parasitoid, *Dirhinus giffardii* (Silvestri) on *Bactrocera zonata* (Saunders) at various depths of plant debris. J. Basic Appl. Sci., 12: 164-169

Charnov, E.L. and D.W. Stephens, 1988. On the evolution of host selection in solitary parasitoids. Am. Nat., 707-722.

De Meyer, M., M.P. Robertson, M.W. Mansell, S. Ekesi, K. Tsuruta, W. Mwaiko, J.F. Vayssieres and A.T. Peterson, 2010. Ecological niche and potential geographic distribution of the Invasive Fruit Fly *Bactrocera invadens* (Diptera, Tephritidae). B. Entomol. Res., 100, 35-48.

Dowell, R.V. and L.K. Wange, 1986. Process analysis and failure avoidance in fruit fly programs. Pest Control (ed. by Mangel, M., Carey, J.R., and Plant, R.E.), pp. 43–65. NATO ASI Series, Springer-Verlag, New York.

Drew, R.A.I., K. Tsuruta and I.M. White, 2005. A new species of pest fruit fly (Diptera: Tephritidae: Dacinae) from Sri Lanka and Africa. Afr. Entomol., 13(1): 149-154.

Jiang, F., Z.H. Li, Y.L. Deng, J.J. Wu, R.S. Liu and N. Buahom, 2013. Rapid diagnosis of the economically important fruit fly, *Bactrocera correcta* (Diptera: Tephritidae) based on a species-specific barcoding cytochrome oxidase I marker. Bull. Entomol. Res., 103(3): 363-371.

Joomaye, A., N.S. Price, J.M. Stonehouse and I. Seewooruthun, 2000. Quarantine pest risk analysis of fruit flies in the Indian Ocean: the case of *Bactrocera zonata*. In: Price NS, Seewooruthun I editors. Proceedings of the Indian Ocean Commissio, Regional Fruit Fly Symposium, Flic en Flac 2000; 5th-9th June 2000; Reduit, Mauritius. Regional Fruit Fly Programme, Ministry of Agriculture, Food Technology and Natural Resources, pp. 179-183.

Metcalf, R.L. and E.R. Metcalf, 1992. Fruit Flies of Family Tephritidae. İn: Metcalf RL, Metcalf ER, editors. Plant Kairomones in Ins. Ecol. Cont. London: Chapman and Hall, pp. 109-152.

Naveed, M., A. Sohail, N. Ahmad, I. Rauf and W. Akbar, 2014.The role of *Dirhinus giffardi* (Silvestri) on the age of parasitism preference to different days old pupae of *Bactrocera zonata* and *Bactrocera cucurbitae*. J. Agric. Biotech. Sustain. Dev., 6(1): 1-5.

Ni, W.L., Z.H. Li, H.J. Chen, F.H. Wan, W.W. Qu, Z. Zhang and D.J. Critics, 2012. Including climate change in pest risk assessment: the peach fruit fly, *Bactrocera zonata* (Diptera: Tephritidae). Bull. Entomol. Res., 102(2):173-83.

Noyes, J.S., 2001. Interactive catalogue of world Chalcidoidea Electronic compact disc by Taxapad, Vancouver Canada and the Natural History Museum, London 2002.

Pfannenstiel, R.S., H.W. Browning and J.W. Smith, 1996. Suitability of Mexican rice borer (Lepidoptera: Pyralidae) as a host for *Pediobius furvus* (Hymenoptera: Eulophidae). Environ. Entomol., 25(3): 672-676.

Rauf, I., N. Ahmad, S.M.S. Rashdi, M. Ismail and M.H. Khan, 2013. Laboratory studies on ovipositional preference of the peach fruit fly *Bactrocera zonata* (Saunders) (Diptera: Tephiritidae) for different host fruits. Afr. J. Agric. Res., 8(15): 1300-1303.

Shah, A.K., M. Khan, G. Nahar and F. Yesmin, 2007. Impact of natural hosts and artificial adult diets on some quality parameters of *Bactrocera cucurbitae*. Pak. J. Biol Sci., 10(1): 178-181.

Sookar, P., M. Alleck, N. Ahseek, S. Permalloo, S. Bhagwant and C.L. Chang, 2014. Artificial rearing of the peach fruit fly *Bactrocera zonata* (Diptera: Tephritidae). Int. J. Trop. Ins. Sci., 34(1):99-107.

Steel, R.G.D. and J.H. Torrie, 1980. Principles and Procedures of Statistics. A biometric approach. 2nd edition. Me-Graw Hill Book Co. Inc., NY, USA, 20-90.

Stonehouse, J.M., J.D. Mumford and G. Mustafa, 1998. Economic losses to Tephritid fruit flies (Diptera: Tephritidae) in Pakistan. Crop Prot., 17: 159-164.

Uchoa, M.A. and J.N. Nicacio, 2010. New records of Neotropical fruit flies (Tephritidae), lance flies (Lonchaeidae) (Diptera: Tephritoidea), and their host plants in the South Pantanal and adjacent areas, Brazil. Ann. Entomol. Soc. Am., 103 (5): 723-733

Van Lenteren, J.C., J.S. Bale, F. Bigler, H.M.T. Hokkanen and A.J.M. Loomans, 2006. Assessing risks of releasing exotic biological control agents of arthropod pests. Annu. Rev. Entomol., 51: 609-634.

Van, D., R.M. Hoddle and T. Center, 2008. Book on Control of Pests and Weed by Natural Enemies, Hoboken, NJ, USA: Wiley-Blackwell.

Wang, X.G. and R.H. Messing, 2004. Potential interactions between pupal and egg-or larval-pupal parasitoids of tephritid fruit flies. Environ. Entomol., 33(5): 1313-1320.

White, I.M., 2000. Identification of peach fruit fly, Bactrocerazonata (Saunders), in the Eastern Mediterranean. *The Natural History Museum.*

White, I.M. and M.M. Elson-Harris, 1992. Fruit flies of economic significance: their identification and bionomics. CAB International, Wallingford, United Kingdom.

Zhao, H.Y., L. Kui, A. Shaukat, Y.L. Yong, Z. Ling and W.L. Guang, 2013. Host Suitability of different pupal ages of oriental fruit fly, *Bactrocera dorsalis*, for the parasitoid, *Pachycrepoideus vindemmiae*. Pak. J. Zool., 45(3): 673-678.