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Short Communication

Controlling *Bactrocera* spp. (Diptera: Tephritidae) Through Release of Parasitoids and Mass-Trapping in Orchard Agro-Ecosystem of Sindh

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ZUAA performed the experiments, analyzed the data and wrote the manuscript. NB supervised the study. RMM conceived the study. NHK designed the experiments.

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Dipteran fruit flies, Beneficial insects, Experimental blocks, Discrete locations, Fruit orchards

ABSTRACT

Fruit flies of genus *Bactrocera* are devastating pests of fruits and vegetables among them *Bactrocera zonata* and *Bactrocera dorsalis* (Diptera: Tephritidae) are principal pests of mango and guava growing areas of Sindh. Field studies were conducted in mango and guava experimented orchards of Sindh to determine the effectiveness of *Trybliographa daci* and *Diachasmimorpha longicaudata* against *Bactrocera* flies in combination with mass trapping. Results shown significantly ($P<0.05$) maximum parasitization of *T. daci* (342.00±16.26, 320.00±14.85) respectively in EA-2 (guava) treated blocks at Hyderabad and Larkana. Whereas, minimum parasitization of both parasitoids were observed in the untreated blocks of mango at discrete regions. Furthermore, significantly ($P<0.05$) reduced number of *B. dorsalis* (510.00±118.57, 558.40±75.86) followed *B. zonata* (611.80±109.38, 680.00±40.50) respectively were found in EA-1(mango) treated blocks of Larkana and Hyderabad using mass-trapping technique for fruit flies. While higher number of both species of fruit flies were recorded in untreated blocks of guava at both experimental sites. Present Investigations suggested that in spite of expected results of both parasitoids releases and mass trapping other eco-friendly techniques are also necessary to reduce the amount of injuries caused by *Bactrocera* species in mango and guava orchards of Sindh.

The dipteran fruit flies of family Tephritidae genus *Bactrocera* consist of economically important species such as *Bactrocera zonata* (Saunders) and *Bactrocera dorsalis* (Hendel) are the major pest species of guava, mango, papaya, peach, pear etc. (Drew and Lloyd, 1989). These species have been distressing pests over 2000 and infestation caused by the larvae diminishes quality of the fruit (Kapoor, 1993). Various studies have been carried out to destroy these pests amongst the techniques applied to control fruit flies chemical control methods are extensively used nevertheless these chemicals has harmful influence on atmosphere and useful insects (Hardy, 1979).

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Sex pheromones for monitoring and managing *Bactrocera* flies have been used in Pakistan (Gillani *et al*., 2002; Mahmood and Mishkatullah, 2007; Abro *et al*., 2021). For the safety of beneficial insects the mass trapping technique has been developed as an important tool for managing fruit flies (Haniotakis *et al*., 1991; Montiel and Jones, 2002; Ragoussis, 2002). The use of parasitoids as bio-control agents has been developed and fruit flies parasitized by a number of parasitoid species (Clausen, 1978). The rearing tactics of parasitoids on factitious hosts have been conducted to develop and enable them against *Bactrocera* flies (Kapatos and Fletcher, 1984; Jimenez *et al*., 1990). Investigations on finding suitable host for rearing of parasitoids have been made in detail (Mohamed *et al*., 2007). In current studies we have made efforts to test combined efficacy of mass releases of *T. daci* and *D. longicaudata* along with mass-trapping tactic to manage *B. zonata* and *B. dorsalis* in orchard agro-ecosystem of Sindh.

Materials and methods

Field investigations were made to observe the

combined efficacy of the parasitoids releases and mass-trapping against *Bactrocera* species in mango and guava orchards of Sindh.

The experiments were conducted in mango (*Mangifera indica* L.) and guava (*Psidium guajava* L.) orchards located at NIA. Experimental Farm (25º25'60N 68º31'60E) Hyderabad and Bakrani (27º26'46.66"N 68º11'07.11"E) Larkana. While the untreated (control) orchards were located at 2 Km distant. Experimental blocks at mango orchards of discrete locations were considered as experimental area-1 (EA-1), whereas experimental blocks at guava orchards were considered as experimental area-2 (EA-2) at both locations.The trees selected for the experiments was about 5-10 m in height and trees were planted at an average density of 100 trees/ha. The experiments were designed in randomized complete block design (RCBD) at each site 20 trees were selected for parasitoid releases and mass-trapping.

For parasitoids release the *Trybliographa daci* and *Diachasmimorpha longicaudata* were reared on third instar larvae of the *Bactrocera* species in NIA, Tando Jam and transported to the selected experimental sites. Approximately 10,000 parasitoids were released during study period in mango and guava fields. The parasitoids were released only during fruiting time. No other control measures were applied in experimental blocks during study period (Table I).

For mass trapping, eco-traps were used. These traps of a 15-20 cm plastic jars containing protein hydrolysate (50 g) and Nulure (50 g) food attractants with a small cotton wick dipped with water to maintain the moisture inside the traps were dispersed on trees at EA-1 and EA-2 at both locations at 2 m height in the shade without coming in contact with leaves. Five eco-traps were placed in each experimental area. Each trap was considered as a replicate. This application was intended to decrease the fruit flies population before releasing parasitoids. The data on combined effectiveness of parasitization and mass-trapping were observed.

Statistix® version 8.1, Analytical Software, Inc., and Tallahassee, FL, USA were used for statistical analyses of the data. Two-ways ANOVA for different parameters were performed followed by Fisher's (LSD) Test to check the significance of data.

Results

Results revealed significantly (P<0.05) maximum parasitization of *T. daci* (342.00±16.26, 320.00±14.85) followed by *D. longicaudata* (204.20±9.65, 196.20±14.83), respectively in guava treated blocks at Hyderabad and Larkana. Whereas, minimum parasitization of both parasitoids were observed in the untreated blocks of mango at discrete regions (Table II, Fig. 1).

Table I. Total number of parasitoids released separately in experimental areas located at Larkana and Hydraabad.

Year	Area	No. of parasitoids released/month		Average no. of parasitoids released/ tree/month
		T. daci	*D. longicaudata*	
2019	EA-1 Mango	400	400	10 ♀ 10 ♂
	EA-2 Guava	400	400	10 ♀ 10 ♂
2020	EA-1 Mango	400	400	10 ♀ 10 ♂
	EA-2 Guava	400	400	10 ♀ 10 ♂
	Total	9,600	9,600	4,800 ♀ 4,800 ♂

Table II. Effectiveness of combined parasitoids releases and mass trapping in mango and guava treated and untreated fields of Larkana and Hyderabad.

Location	Area	Parasitization		Mass trapping	
		T. daci	*D. longicaudata*	*B. zonata*	*B. dorsalis*
Larkana	EA-1 Mango	210.00±30.66 a	156.00±13.17 a	611.80±109.38 a	510.00±118.57 a
	Control	30.40±3.11 a	16.20±2.22 b	926.00±43.20 a	684.00±78.65 b
	EA-2 Guava	320.00±14.85 a	196.20±14.83 b	791.00±33.44 a	587.60±78.84 a
	Control	39.20±2.08 a	23.80±2.18 b	1020.00±18.97 a	867.60±37.52 b
Hyderabad	EA-1 Mango	281.60±15.38 a	175.40±3.78 b	680.00±40.50 a	558.40±75.86 a
	Control	37.40±1.50 a	18.40±1.66 b	980.00±25.69 a	780.00±29.50 b
	EA-2 Guava	342.00±16.26 a	204.20±9.65 b	853.00±39.00 a	650.60±47.19 b
	Control	44.00±1.52 a	27.80±2.08 b	1046.00±14.35 a	910.00±36.19 b

Means (±SE) in the column followed by same letters are not significantly (P < 0.05) different by (LSD) analysis.

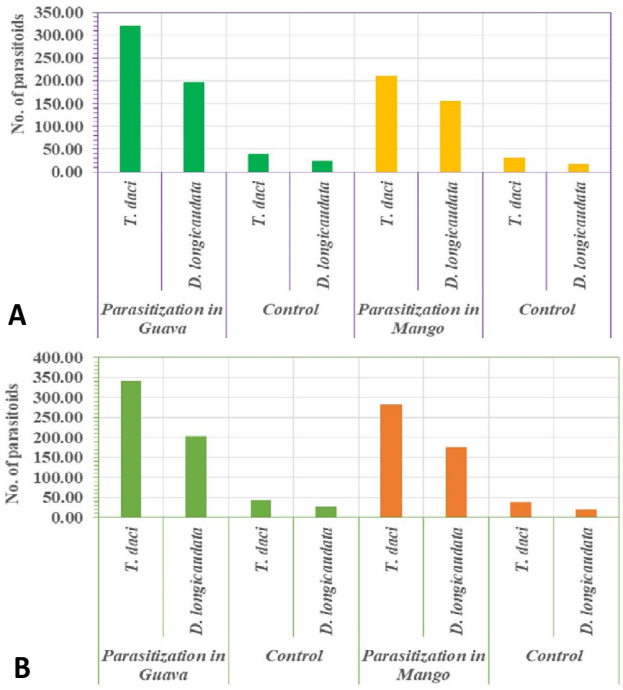

Fig. 1. Efficacy of *T. daci* and *D. longicaudata* released in guava and mango treated and untreated fields of district Larkana (A), and Hyderabad (B).

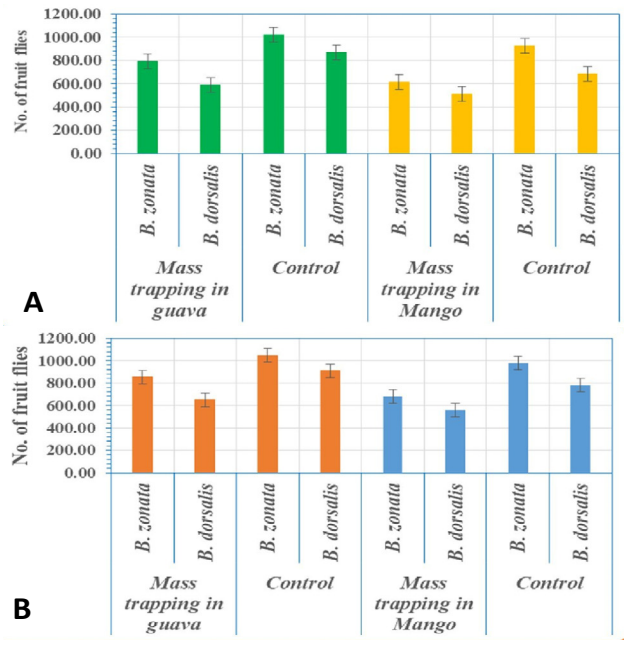

Fig. 2. Capturing of *B. zonata* and *B. dorsalis* through mass-trapping from guava and mango treated and untreated of district Larkana (A), and Hyderabad (B).

Furthermore, significantly (P<0.05) reduced number of *B. dorsalis* (510.00±118.57, 558.40±75.86) followed *B. zonata* (611.80±109.38, 680.00±40.50) respectively were found in mango treated blocks of Larkana and Hyderabad using mass-trapping technique for fruit flies. While higher number of both species of fruit flies were recorded in untreated blocks of guava at both experimental sites (Fig. 2).

Additionally maximum parasitization percentage were recorded in guava by *T. daci* at both experimental sites (Fig. 3).

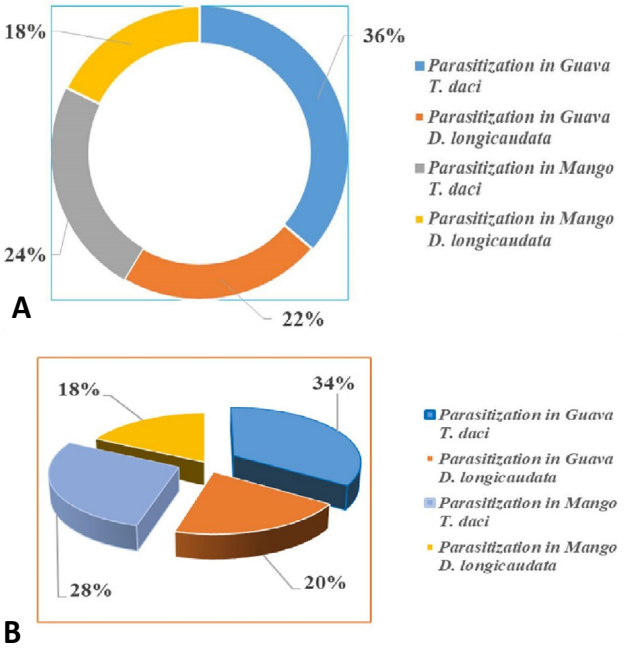

Fig. 3. Parasitizing (%) obtained by releasing *T. daci* and *D. Longicau* data in guava and mango treated fields of district Larkana (A), and Hyderabad (B).

Discussion

We have experimented the combined efficacy of field releases of *T. daci* and *D. longicaudata* alongside mass-trapping of fruit flies which proved effective and no such studies on parasitoids releases along with mass-trapping have been reported and published yet in Pakistan thus our results are in similarity with that of Loni and Canale (2005) who successfully examined the releases of *P. concolor* beside with eco-traps to achieve control against med fly. In Greece, Mazomenos *et al*. (2002) carried out studies by releasing *P. concolor* with mass traps during 2004 in olive trees against *Bactrocera oleae* which shown 38% parasitization in the treated plots 10% control the ratio resembles with our findings on treated and untreated blocks. Mcinnis *et al*. (2004) and Vargas *et al*. (2004) released *Psyttalia fletcheri* (Silvestri) with

sterile flies to supress *Bactrocera cucurbitae* (Coquillet) in Hawaii to check field efficacy of the parasitoids, just as we determined the use of combined techniques to suppress fruit flies in agro-ecosystem are in agreement with above researchers.

In recent years combined effectiveness of augmentative field releases of parasitoids and mass trapping of fruit flies using eco-traps in Turkey were observed by Hepdurgan *et al*. (2009) who suggested combination of different tactics to control fruit flies on area wide basis is more operative and environmentally harmless. We also suggest the application of different fruit flies controlling techniques along with biocontrol technology are essential for eco-friendly management of fruit flies in orchard agro-ecosystem.

Conclusion

T. daci proved dynamic in parasitizing fruit flies under field conditions in both climatic regions of Sindh. Furthermore, reduced number of *B. zonata* and *B. dorsalis* were recorded from treated blocks of guava and mango that shown the effectiveness of released parasitoids. *T. daci* may be mass reared on *B. zonata* given suitable lab conditions could be successfully used as biological control agent in environmental conditions of Sindh.

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IRB approval

Authors would like to confirm that the study protocol for this study was reviewed and approved by the independent ethics committee.

Ethics Statement

The authors comply with all laws and regulations that apply to science and profession during the period of studies.

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Statement of conflict of interest

The authors have declared no conflict of interest.

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