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Population Fluctuations of *Bactrocera* Species (Diptera: Tephritidae) in Guava and Mango Orchards at Different Climatic Conditions of Sindh

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Authors' Contribution
ZUAA performed the experiments, analyzed the data and wrote the article. NB supervised the study. RMM conceived the study. NHK designed the experiments. IS assisted in experiments.

Key words
***Bactrocera* species, Population dynamics, Fruit orchards, Climatic zones, MAT**

ABSTRACT

Two *Bactrocera* spp. of fruit fly (*Bactrocera zonata* and *Bactrocera dorsalis*) (Diptera: Tephritidae) associated with mango and guava fruits were studied during (January, 2019 to December, 2019) to determine the population dynamics of these notorious pests in different climatic zones of Sindh Province. Steiner type (Tando Jam) traps baited with methyl eugenol and 5% pesticide were incorporated in the guava and mango orchards of Hyderabad and Larkana. Fruit flies were trapped in the field throughout the year. The results revealed the distinct patterns of population dynamics at both climatic zones. The population density was greater for *B. zonata* as compared *B. dorsalis* in guava and mango orchards of both climatic zones. Peak population of Both *Bactrocera* spp. were observed in the August and June at guava and mango orchards of Sindh. The maximum number of *B. zonata* (989.40±75.24, 943.60±70.36) followed by *B. dorsalis* (708.70±21.80, 389.20±16.58) respectively were observed in off-seasoned guava at Hyderabad and Larkana. Whereas, higher population of *B. zonata* followed by *B. dorsalis* (623.50±14.76, 588.80±20.62 and 440.90±24.59, 400.40±11.86) respectively were inspected from seasoned mango orchards of both climatic regions. Minimum population of both fruit flies were obtained in January from guava and mango orchards of different climatic zones. The fruit flies density were affected by temperature and relative humidity. However, the stronger connection of population increase with matured fruits were exhibited. The present efforts would be supportive to eliminate *Bactrocera* species from different orchard agro-ecosystem of Sindh by using MAT in integration of other eco-friendly management techniques for fruit flies.

INTRODUCTION

Bactrocera spp. of fruit fly are unquestionably the most notorious pests of fruits and vegetables all over Asia and World. The species of genus *Bactrocera* known as constant destructive pests (Wang, 1996). For demographic studies on population dynamics development and movement are key tools (Price, 1997). Analysis of various factors such as forecasting biological parameters, scrutinising population build-up and constancy, approximating extinction chances and examining expected outbreaks are required for demographic populations (McPeek and Kalisz, 1993). The peach fruit fly, *Bactrocera zonata* (Saunders) and Oriental fruit fly, *Bactrocera dorsalis* (Hendel) are polyphagous pests and predominantly infesting peach, guava and mango (CABI/EPPO, 2001). Both *Bactrocera* species are major pests in India and Pakistan (Qureshi *et al*., 1993). According to available literature *B. zonata* is more significant pest species in Pakistan compared to *B. dorsalis* (Siddiqui *et al*., 2003; Sarwar *et al*., 2014; Abro *et al*., 2020). The influence of temperature on the growth and persistence of Hawaiian fruit fly species have been defined by (Vargas *et al*., 1996). For management of *Bactrocera* spp. many scientists have recommended demographic studies (Carey and Vargas, 1985; Vargas and Nishida 1985; Vargas and Carey, 1990). Fruit flies inflict 210 million US dollars and an estimated 190 million Euro damages of fruits in a year (USDA, 2016). With increasing international trade fruit flies become major quarantine pests of fruits and vegetables which not only create

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hindrances in exportation of fruits and vegetables but also reduce their average production (White and Elson-Harris, 1992). To make fruits completely free from infestation of fruit flies it is indispensable to control them round the year from different hosts as described in the breeding flow of the flies. The present studies were designed for the first time on comparative demography of two *Bactrocera* spp. in mango and guava orchard-ecosystem of two ecological zones of Sindh to develop better pest management strategy on demographic basis.

MATERIALS AND METHODS

The field investigations were conducted for the comparative demography of *Bactrocera* spp. in the (*Psidium guajava* L.) and mango (*Mangifera indica* L.) growing orchards at (25º25'60N 68º31'60E) Hyderabad and (27º26'46.66"N 68º11'07.11"E) Larkana. The area under observation mainly consist mango, guava surrounded by seasonal vegetables and cotton crop in Hyderabad while in Larkana it consisted mango, guava surrounded by wheat and rice crops.

The fruit fly traps were made of translucent plastic bottles about 2 litres volume having two holes on each side to facilitate the fruit flies entrance inside when appealed by lure (4 ml methyl eugenol) suspended inside each trap from another end near the center. The male flies attracted by lure were quickly killed by the insecticide (Pyramid 10% AS) which is dipped along with methyl eugenol on cotton wick and placed inside the traps. The traps used are locally known as Tando Jam Traps.

The traps were installed at three meters height on all planted mango and guava trees in both regions during 01-01-2019 to 31-12-2019. The male captivities of both fruit fly species were collected on weekly basis and lure were replenished at fortnight interval. The trapped flies were transported to the Fruit Flies Laboratories, Nuclear Institute of Agriculture, Tando Jam. The flies were identified using scientific methods for identification of fruit flies at species level. The identified flies of each trap were counted and kept individually for the record.

The entire studies were designated on the 5 acres area of mango and guava orchards each at diverse localities of Hyderabad and Larkana regions. The impact of abiotic factors such as temperature (ºC) and relative humidity (%) were also observed on the demography of *Bactrocera* species. Experiments were designed in Randomized Complete Block Design (RCBD) having ten replications. Where each trap was considered as 1 replicate.

Meteorological data used in this study were provided by Regional AGRO-MET Centre Tando Jam and Larkana, Sindh, Pakistan. The data collected for these periods were month wisely summarized and compared with the data of insect count.

All statistical analyses were done with the help of Statistix® Version 8.1, Analytical Software, Inc., and Tallahassee, FL, USA. Statistical analysis was calculated using two-ways analysis of variance ANOVA for different parameters Followed by Tukey's Post Hoc HSD Test for the significance of data.

RESULTS AND DISCUSSION

During month wise comparative demographic studies on the population dynamics of *Bactrocera* spp. revealed distinct variabilities in guava and mango orchards of Hyderabad and Larkana. Comparatively maximum number of *B. zonata* was observed in both regions. However, ($P<0.05$) maximum number of *B. zonata* were observed in off-seasoned guava in the month of August at Hyderabad and Larkana regions (989.40±75.24, 943.60±70.36) followed by *B. dorsalis* (708.70±21.80, 389.20±16.58), respectively (Table I). Whereas, in the month of June peak population of *B. zonata* was recorded in seasoned mango at Hyderabad and Larkana regions (623.50±14.76, 588.80±20.62) followed by *B. dorsalis* (440.90±24.59, 400.40±11.86), respectively (Table II). Nevertheless, less activity of both fruit flies were observed in the month of January in both fruiting orchards at different regions. Furthermore, results revealed that abiotic factors significantly ($p<0.001$) correlated with the population dynamics *B. zonata* and *B. dorsalis* of both studied sites at different locations (Table III). Nonetheless, the positive correlation between temperature (ºC) and fruit flies population were observed in Hyderabad and Larkana region in guava and mango fields (Figs. 1A, 2A, 3A, 4A). Relative humidity has negative impact on the demographic parameters of the *Bactrocera* spp. in both regions (Figs. 1B, 2B, 3B, 4B).

Several comparative demographic studies on different *Bactrocera* spp. conceded to observe their activities in the field (Vargas *et al*., 2000; Brevault and Quilici, 2000). These studies have shown maximum activity of the principal fruit fly pest species. Similarly, in our studies we have found the greater number of *B. zonata* which is dominating pest infesting fruits in Sindh in comparison with *B. dorsalis*. Clarke *et al*. (2001) reported that maximum temperature up surged the population dynamism of fruit fly species likewise our observations established that increase in temperature tallies growth of both *Bactrocera* spp. in Sindh region. Prominently tephritid fruit flies lavishness and dispersal have been controlled by climatic conditions inclusion with other biotic elements.

Table I. Month-wise population fluctuations of *Bactrocera* spp. (mean no. of flies/trap±SE) in guava orchard-agroecosystem of Sindh during 2019.

Months of 2019	Hyderabad		Larkana	
	B. zonata	*B. dorsalis*	*B. zonata*	*B. dorsalis*
January	17.90±1.04 e	10.80±1.33 f	12.20±0.80 f	8.70±0.60 g
February	21.60±1.67 e	17.50±0.91 f	18.30±0.91 f	14.50±1.10 g
March	81.80±5.95 de	75.90±3.64 ef	74.50± 5.16 def	61.80±7.74 f
April	159.60±8.93 cd	112.90±4.57 de	151.70±11.02 cd	88.90±5.02 ef
May	224.40± 7.08 c	183.80±10.89 d	214.20±17.21 c	95.20±3.93 def
June	257.60±16.99 c	181.10±18.45 d	246.00±20.33 c	119.80±8.87 de
July	572.80±18.41 b	491.90±23.84 b	557.20±30.46 b	198.70±12.57 c
August	989.40±75.24 a	708.70±21.80 a	943.60±70.36 a	389.20±16.58 a
September	535.70±16.51 b	144.60±11.69 c	508.60±32.74 b	335.90±16.45 b
October	150.10±7.07 cd	18.80±1.98 de	142.90±7.61 cde	136.90±7.57 d
November	30.20±2.94 e	11.80±1.64 f	26.30±2.64 ef	14.60±0.86 g
December	18.50±1.02 e	11.80±0.98 f	15.60±1.33 f	9.90±0.64 g

Values followed by different letters are significantly differ at 5% according to Tukey's Honest Significant Difference (HSD) test.

Table II. Month-wise population fluctuations of *Bactrocera* spp. (mean no. of flies/trap±SE) in mango orchard-agroecosystem of Sindh during 2019.

Months of 2019	Hyderabad		Larkana	
	B. zonata	*B. dorsalis*	*B. zonata*	*B. dorsalis*
January	11.30±1.01 f	8.10±0.41 d	5.80±0.63 f	3.60±0.52 f
February	14.80±1.35 f	12.90±0.69 d	10.50±1.15 f	8.60±0.82 f
March	101.40±11.46 e	96.10±6.94 cd	91.90± 2.63 de	80.50±3.54 de
April	216.30±13.02 d	208.90±15.71 b	192.50±12.04 c	120.40±8.41 d
May	498.80± 24.25 b	388.00±42.21 a	413.50±4.20 b	278.30±14.97 b
June	623.50±14.76 a	440.90±24.59 a	588.80±20.62 a	400.40±11.86 a
July	564.40±23.54 a	287.60±28.58 b	561.10±28.27 a	315.70±23.85 b
August	396.90±16.90 c	217.40±24.67 b	385.60±14.45 b	177.10±13.81 c
September	221.40±21.37 d	110.50±28.14 c	107.20±14.45 d	65.30±5.62 e
October	48.40±6.19 ef	34.20±4.11 cd	41.50±3.22d ef	12.20±0.59 f
November	20.60±1.97 f	11.80±1.64 d	13.90±0.99 f	5.70±0.79 f
December	11.90±0.92 f	8.50±1.15 d	7.90±0.57 f	4.80±0.42 f

Values followed by different letters are significantly differ at 5% according to Tukey's Honest Significant Difference (HSD) test.

Table III. Pearson's correlation between weather parameters and month wise population fluctuations of *Bactrocera* spp. in guava and mango orchard-agroecosystem of Sindh during 2019.

Meteorological factors		Hyderabad		Larkana	
		B. zonata	*B. dorsalis*	*B. zonata*	*B. dorsalis*
Guava orchards					
Temp(°C)	Minimum	0.7276*	0.7467*	0.7199*	0.7392*
	Maximum	0.4872*	0.5087*	0.6149*	0.6160*
Relative humidity (%)		-0.7064	-0.6970	-0.0304	-0.0941
Mango orchards					
Temp(°C)	Minimum	0.8407 *	0.7764*	0.7981*	0.7606*
	Maximum	0.7693*	0.8021*	0.8390*	0.8247*
Relative humidity (%)		-0.1268	-0.1197	-0.6635	-0.7480

*Positively significant at ($p < 0.001$) according to Pearson's correlation significance test.

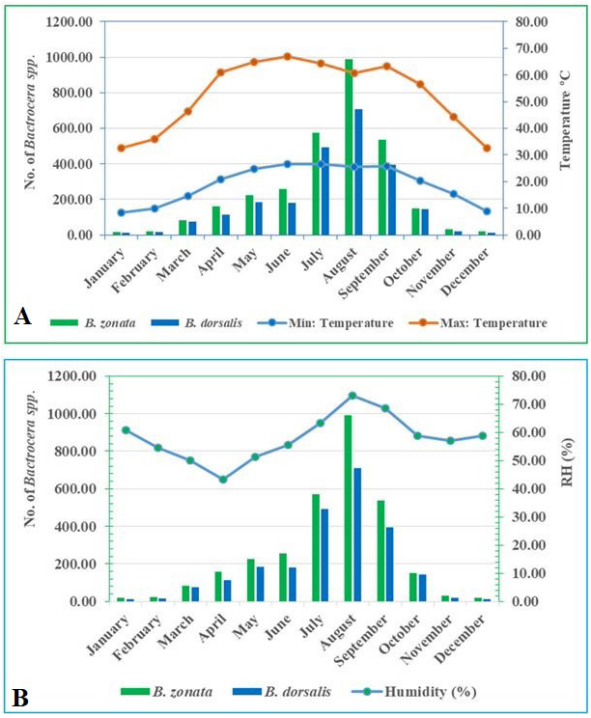

Fig. 1. Impact of temperature (A) relative humidity (%) (B) on population fluctuations of *Bactrocera* spp. In guava orchard agro-ecosystem of Hyderabad.

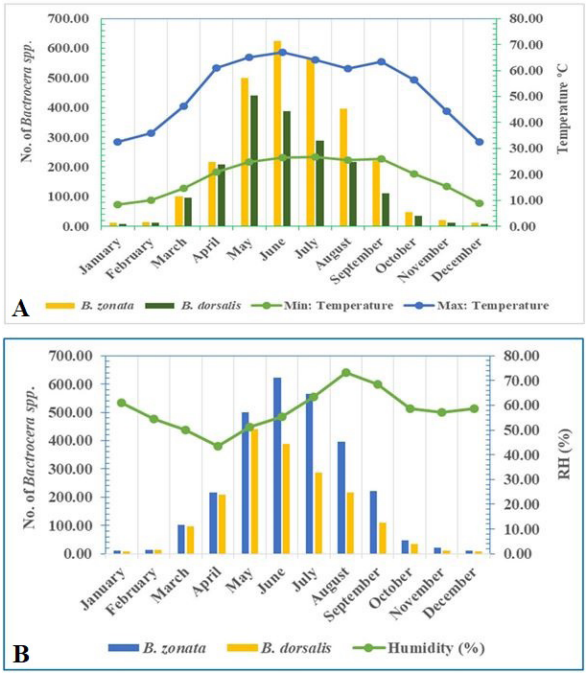

Fig. 2. Impact of temperature (A) relative humidity (%) (B) on population fluctuations of *Bactrocera* spp. In mango orchard agro-ecosystem of Hyderabad.

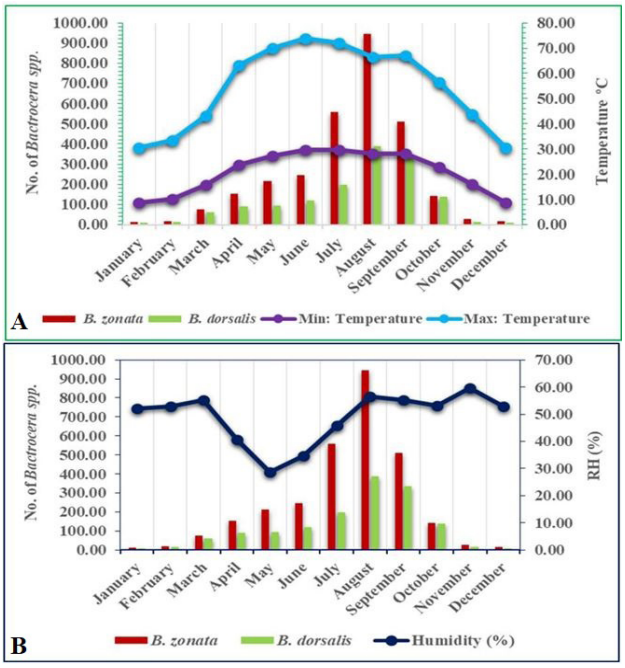

Fig. 3. Impact of temperature (A) relative humidity (%) (B) on population fluctuations of *Bactrocera* spp. In guava orchard agro-ecosystem of Larkana.

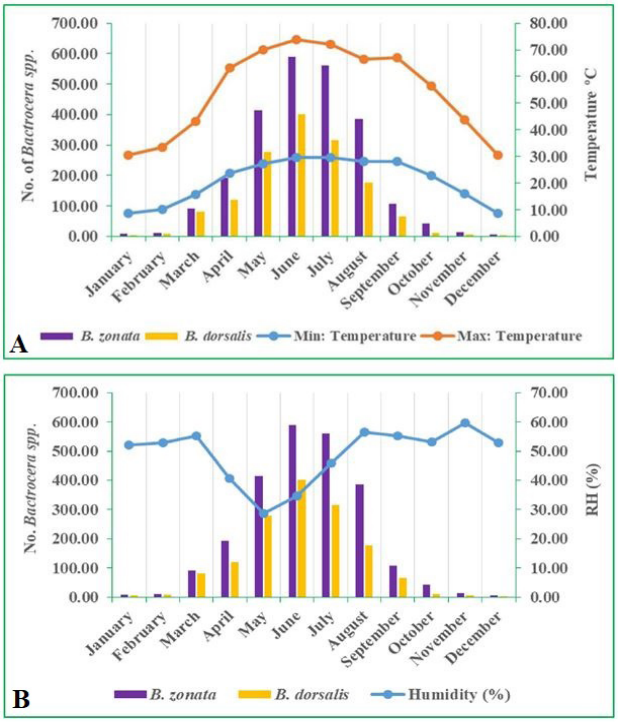

Fig. 4. Impact of temperature (A) relative humidity (%) (B) on population fluctuations of *Bactrocera* spp. in mango orchard agro-ecosystem of Larkana.

(Esculdero-Colomar *et al*., 2008; Muthuthantri *et al*., 2010). Our findings are in line with above researchers as abundance of both *Bactrocera* species were recorded during high temperature months with prevue to maturing fruits. Dyuck *et al*. (2004) perceived that temperature has direct impact on the fruit fly species but it lessens the interspecific competition however we did not find such results. Our revisions established that population of *B. zonata* and *B. dorsalis* started to decline after September in guava and mango orchards in Hyderabad and Larkana the results are slightly different by (Win *et al*., 2014) who reported decline in population of fruit flies after August. Similarly, (Mahmood and Mishkatullah, 2007) in earlier studies investigated the peak population of *Bactrocera* species in the August matched with our observations. The population build-up of fruit flies started from April and peak level attained in June and August at Mango and Guava orchards of both regions. The findings coincided (Gillani *et al*., 2002) who recorded maximum catches in August during unseasonal guava. Amice and Sales (1997) professed that fruit flies population encouraged by the (Temperature ºC) and dejected (RH %) our results are in agreement with these previous researchers.

CONCLUSION

In current studies on comparative demography of *Bactrocera* species it is concluded that *Bactrocera zonata* is the dominated fruit flies pest species inhabiting the different climatic conditions. Moreover, greater temperature boosts the movement of *Bactrocera* species in the field pertaining availability to ripened fruits.

In conclusion, comparative demographic patterns of tephritid fruit flies are worthwhile in forecasting the ecological distributions and latitudinal inclines in order to reduce their population below economic injury level.

Hence the present studies provided the worthy background and excessive data for Scientists, researchers and pest management companies working to control tephritid fruit flies in the region.

Statement of conflict of interest

The authors have declared no conflict of interest.

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