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Population dynamics and seasonal incidence of two Tephritid fruit fly species in mango ecosystem under off-season fruiting in Tamil Nadu

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Abstract
The population dynamics of two Tephritid fruit fly species-*Bactrocera dorsalis* Hendel and *Bactrocera correcta* Bezzi-was studied in an off-season fruiting mango ecosystem at Pappanoor of Krishnagiri district in Tamil Naduduring January-December 2018. The population fluctuation of fruit flies in the mango orchard was recorded as fly catches in methyl eugenol traps at successive fortnightly intervals in fixed locations. The *B. dorsalis* population was found to gradually increase from first fortnight of April (at 6.5 flies/trap/fortnight) and reached its first peak during first fortnight of July (with113.5 flies/trap/ fortnight). Later a second peak in the *B. dorsalis* numbers occurred in the second first fortnight of September (80.0 flies/trap/fortnight). In case of *B. correcta*, the first peak was observed during second fortnight of May (15.5 flies/trap/fortnight) and a second peak at first fortnight of September (15.0 flies/trap/fortnight). Where after the *B. correcta* population started declining to reach the lowest numbers in second fortnight of December (2.0 flies/trap/fortnight). Three weather parameters together tended to influence the trap catches of *B. dorsalis* and *B. correcta* to the extent of 48 and 53 per cent, respectively. The significance of these results in future local management of fruit fly populations is indicated.

Keywords: Mango, population dynamics, *Bactrocera dorsalis*, *B. correcta*, weather effects

Introduction
Mango (*Mangifera indica* L.), is among the more delicious tropical fruits with an outstanding flavor and there are many cultivated varieties which are popular among the consumers. While normal mango crop in most parts of India provides fruits for harvest during March to August, offseason bearing is a special feature wherein the local climatic factors support flowering and fruiting in an additional season (off-season) during October to January. The major pests which affect the marketable fruit yields in mango in the country are Tephritid fruit flies, which include *Bactrocera dorsalis* (Hendel) and *Bactrocera correcta* Bezzi, which are common in mango ecosystem (Nath and Bhushan, 2006) [11]. The Male Annihilation Technique (MAT) using methyl eugenol along with insecticides (like Malathion) has been deployed to suppress the male populations of *B. dorsalis* (Singh *et al*., 2013) [16]. Of course, the type of substrate used as carrier for the para-pheromone may influence the mass trapping impact (Patel *et al*., 2005). In the present paper recent studies on population dynamics of fruit fly and relationship with weather parameters in an offseason were made in off season fruiting mango orchard located in Krishnagiri district of Tamil Nadu and the results therefrom are discussed.

Materials and Methods
Population dynamics of two species of fruit flies were observed with Methyl eugenol traps (from Sun Agro Biotech Research Centre, Chennai). The study was made on Bangalore variety off season mango orchard at J. Pappanoor village of Bargur block in Krishnagiri District from January to December 2018. Two standard plastic white cylindrical jar traps (15 cm high×10 cm dia) with the parapheromone lure known to attract both *B. dorsalis and B. correcta.* Were hung on lower branches in three distant mango trees kept as two replications, the distance between replicates being about 50 meters. The fruit flies collected from each trap were identified at species level by using the taxonomic key published by David and Ramani (2011) [2]. The pooled data for each fortnight across the study period was subjected to ANOVA. The weather parameters *viz.*, maximum and minimum temperatures (ºC) and rainfall (mm) were also recorded for the same period.

Tests of correlation between weather parameters and the fortnightly trap catches of the two fruit fly species were undertaken as per methods described by Gomez and Gomez (1963) [3].

Results and Discussion

The Population dynamics study of the two fruit fly species namely, *B. dorsalis* and *B. correcta* estimated by fortnightly catches in the traps during January to December 2018, clarified the year round occurrence of fruit flies in the offseason mango ecosystem (Table 1).

The *B. dorsalis* catches during the first six fortnights were none to negligible while increasing from first fortnight of April with 6.5 flies/trap/fortnight (Table 1) and reaching. Its first peak during first fortnight of July recording 113.5 flies/trap/fortnight. The catches of *B. dorsalis* gradually decreased from second fortnight of July (76.0 flies/trap/fortnight) till second fortnight of August (26.5 flies/trap/fortnight). Again the *B. dorsalis* population gradually increased from first fortnight of September (74.5 flies/trap/fortnight) to reach the second peak during the second fortnight of September (80.0 flies/trap/fortnight). Thereafter the *B. dorsalis* population tended to gradually decline from first fortnight of October (49.50 fruit flies/trap/fortnight interval) to second fortnight of December (4.0 flies/trap/fortnight). During the present study period, two peaks could be noticed i.e. first peak during first fortnight of July and second peak during second fortnight of September. The results also revealed that there was considerable variation in *B. dorsalis* population across the 24 fortnights studied, which were apparently influenced by crop phenology, besides the key weather parameters like maximum temperatures, minimum temperatures and rainfall (Figure 1).

The present findings are in conformity with the results of Nair (1995) [10] who recorded that the peak population of fruit fly in India was during the months of July and August, besides the findings of Chaudhary and Jamal (2002) [1] that the incidence of *B. dorsalis* in July, August-October occurs under various environmental condition in Pakistan. These results are also in line with the findings of Ravikumar and Viraktamath (2006) [14] and Ranjitha and Viraktamath (2006) [13] who reported such *B. dorsalis* and *B. correcta* population fluctuation in mango orchard at Dharwad in methyl eugenol traps, that catches of *B. dorsalis* which were 8.33 flies/trap in late July and reached a major peak of 22.47 flies during late August.

There was significant positive correlation of *B. dorsalis* trap catches with and minimum temperature (r = 0.637) besides lack of significant correlation with maximum temperature and rainfall, with overall influence by the weather parameters on trap catches to the extent of 48 per cent (Table 2). These findings are coinciding with Gajalakshmi *et al*., (2011) [4] who studied yearlong trap catches of local *B. dorsalis* population in mango ecosystems and showed a significant positive association with minimum temperature (r=0.552) and non-significant correlation with maximum temperature and rainfall. Such positive relationship with minimum temperatures had also been recorded elsewhere in India on *B. dorsalis* (Kannan and Venugopala Rao, 2006) [9]. Our findings are also in line with those Sarada *et al*. (2001) [15] who observed that fruit fly population of *Bactrocera* sp. had positive correlation with minimum temperature and positive non-significant correlation with maximum temperature. The present results partly concur with Gupta and Bhatia (2000) [5] who found that trap catches of *B. dorsalis* have a significant positive correlation with minimum temperature, but differ from his observed significant correlation also with maximum temperature, which may be due to differences in local weather patterns.

In case of *B. correcta*, there was low population (4.50 flies/trap/fortnight) during first fortnight of January 2018 (Table 1) and reached its first peak during second fortnight of May recording 15.50 flies/trap/fortnight. Thereafter the trap catches of *B. correcta* tended to fluctuate between first fortnight of June (12.50 flies/trap/fortnight) to second fortnight of August (6.50 flies/trap/fortnight). Thereafter the *B. correcta* population reached its second peak during first fortnight of September (15.00 flies/trap/fortnight). Then then *B. correcta* population started declining from second fortnight of September (14.50 flies/trap/fortnight) to reach the least numbers in second fortnight of December (2.00 flies/trap/fortnight). Thus, during the present study in the offseason fruiting ecosystem two peaks could be observed, the first peak during first fortnight of May and the second peak during first fortnight of September (Figure 1).

These findings are in line with those of Sureshbabu and Viraktamath (2003) [18] who stated that the population fluctuation of fruit flies was dependent on the availability and phenology of the host crops. These results are at variance with the findings of Gajalakshmi *et al*. (2011) [4] who reported that *B. correcta* population was peaked in the month of May at Coimbatore, Kanyakumari and Paiyur. The match in peak with fruiting period in local mango crop was similarly reported by Sarada *et al*., (2001) [15] that the peak fly population in the mango orchard observed from May to July coincided with the fruit maturity period at Tirupati in Andhra Pradesh. Our results are also inconformity with the findings of Ranjitha and Viraktamath (2006) [13] that peak catches of *B. correcta* was observed during August to November.

The present results also showed that trap catches of *B. correcta* had significant positive correlation with minimum temperature (r = 0.656) and rainfall (r = 0.533), but not correlated with maximum temperature, while the weather parameters together tended to influence the trap catches to the extent of 53 per cent (Table 2). Thes results are in line with the findings of Jalaluddin *et al.* (2001) [8] who reported that population of *B. correcta* expressed a significant positive correlation with minimum temperature and rainfall in guava ecosystem in Tamil Nadu. The significant positive correlation with minimum temperature (r=0.548) is similar to the reports by Gajalakshmi *et al*. (2011) [4] and Hendrichs *et al*., (2002) [7]. The present study also corroborates with Sarada *et al*. (2001) [15] and Hasyim *et al*. (2008) [6] that rainfall had positive and highly significant correlation with fruit fly numbers caught in trap.

The distinctness of offseason fruiting ecosystem as influencing the populations of these two commonly occurring species of fruit flies observed in the present study should provide a baseline for local short term forecasting and should be followed up by additional site comparisons so to evolve a more robust local population prediction tool.

Table 1: Fortnightly trap catches of *B. dorsalis* and *B. correcta* in the off season mango ecosystem at Pappanoor village in Krishnagri District (January to December 2018)

Fortnight intervals	Number of fruit flies trapped/fortnight intervals*			
	B. dorsalis	**Mean ± S.D**	***B. correcta***	**Mean ± S.D**
1st fortnight of January 2018	0.00 (0.71) ^{k}	0.00±0.00	9.00 (3.08)^{cdef}	4.50±2.12
2nd fortnight of January 2018	2.00 (1.58)^{jk}	1.00±0.00	0.00 (0.71) ^{f}	0.00±0.00
1st fortnight of February 2018	0.00 (0.71) ^{k}	0.00±0.00	0.00 (0.71) ^{f}	0.00±0.00
2nd fortnight of February 2018	0.00 (0.71) ^{k}	0.00±0.00	0.00 (0.71) ^{f}	0.00±0.00
1st fortnight of March 2018	0.00 (0.71) ^{k}	0.00±0.00	2.00 (1.58)^{ef}	1.00±0.00
2nd fortnight of March 2018	0.00 (0.71) ^{k}	0.00±0.00	0.00 (0.71) ^{f}	0.00±0.00
1st fortnight of April 2018	13.00 (3.67)^{ij}	6.50±2.12	5.00 (2.35) ^{def}	2.50±0.71
2nd fortnight of April 2018	28.00 (5.34)^{hij}	14.00±4.24	9.00 (3.08)^{cdef}	4.50±2.12
1st fortnight of May 2018	58.00 (7.65)^{fgh}	29.00±9.90	20.00 (4.53)^{abc}	10.00±1.41
2nd fortnight of May 2018	73.00 (8.57)^{efg}	36.50±3.54	31.00 (5.61) ^{a}	15.50±9.19
1st fortnight of June 2018	108.00 (10.42) ^{d}	54.00±16.97	25.00 (5.05) ^{ab}	12.50±4.95
2nd fortnight of June 2018	185.00 (13.62) ^{b}	92.50±14.85	16.00 (4.06)^{bcd}	8.00±1.41
1st fortnight of July 2018	227.00 (15.08) ^{a}	113.50±14.85	22.00 (4.74) ^{ab}	11.00±2.83
2nd fortnight of July 2018	152.00 (12.35)^{bc}	76.00±25.46	15.00 (3.94)^{bcd}	7.50±4.95
1st fortnight of August 2018	86.00 (9.30) ^{def}	43.00±19.80	5.00 (2.35) ^{def}	2.50±0.00
2nd fortnight of August 2018	53.00 (7.31)^{fgh}	26.50±10.61	13.00 (3.67)^{bcde}	6.50±0.71
1st fortnight of September 2018	149.00 (12.23) ^{c}	74.50±9.19	30.00 (5.52) ^{a}	15.00±2.83
2nd fortnight of September 2018	160.00 (12.67)^{bc}	80.00±8.49	29.00 (5.43) ^{a}	14.50±6.36
1st fortnight of October 2018	99.00 (9.97) ^{de}	49.50±10.61	15.00 (3.94)^{bc}	7.50±2.12
2st fortnight of October 2018	80.00 (8.97) ^{def}	40.00±2.83	14.00 (3.81)^{bcde}	7.00±1.41
1st fortnight of November 2018	43.00 (6.60)^{ghi}	21.50±4.95	6.00 (2.55) ^{def}	3.00±1.41
2st fortnight of November 2018	34.00 (5.87)^{hij}	17.00±8.49	0.00 (0.71) ^{f}	0.00±0.00
1st fortnight of December 2018	17.00 (4.18)^{ij}	8.50±0.71	2.00 (1.58) ^{def}	1.00±1.41
2nd fortnight of December 2018	8.00 (2.92) ^{j}	4.00±1.41	4.00 (2.12) ^{def}	2.00±1.41

Figures in parentheses are square root transformed values
Mean in a column followed by same letters are not significantly different (P = 0.05) by LSD

Table 2: Correlation and multiple linear regression for weather parameters on trap catches of *B. dorsalis* and *B. correcta* in Mango ecosystem (January-December 2018)

Populations	Correlation Coefficient value			Multiple linear regression equation	Coefficient of determination
	Maxi. Temperature (ºC)	Mini. Temperature (ºC)	Rainfall (mm)		
	(X1)	(X2)	(X3)	(Y)	(R^2)
B. dorsalis	0.245^{NS}	0.637**	0.399^{NS}	$Y= -11.40-8.87X_1+14.89X_2+4.52X_3$	0.480
B. correcta	0.37^{NS}	0.656**	0.533**	$Y= -22.22-0.17X_1+1.67X_2+1.50X_3$	0.531

X_1 = maximum temperature; X_2 = minimum temperature; X_3= rain fall; Y = number of fruit flies.
**significant at 0.01% *ns=not significant

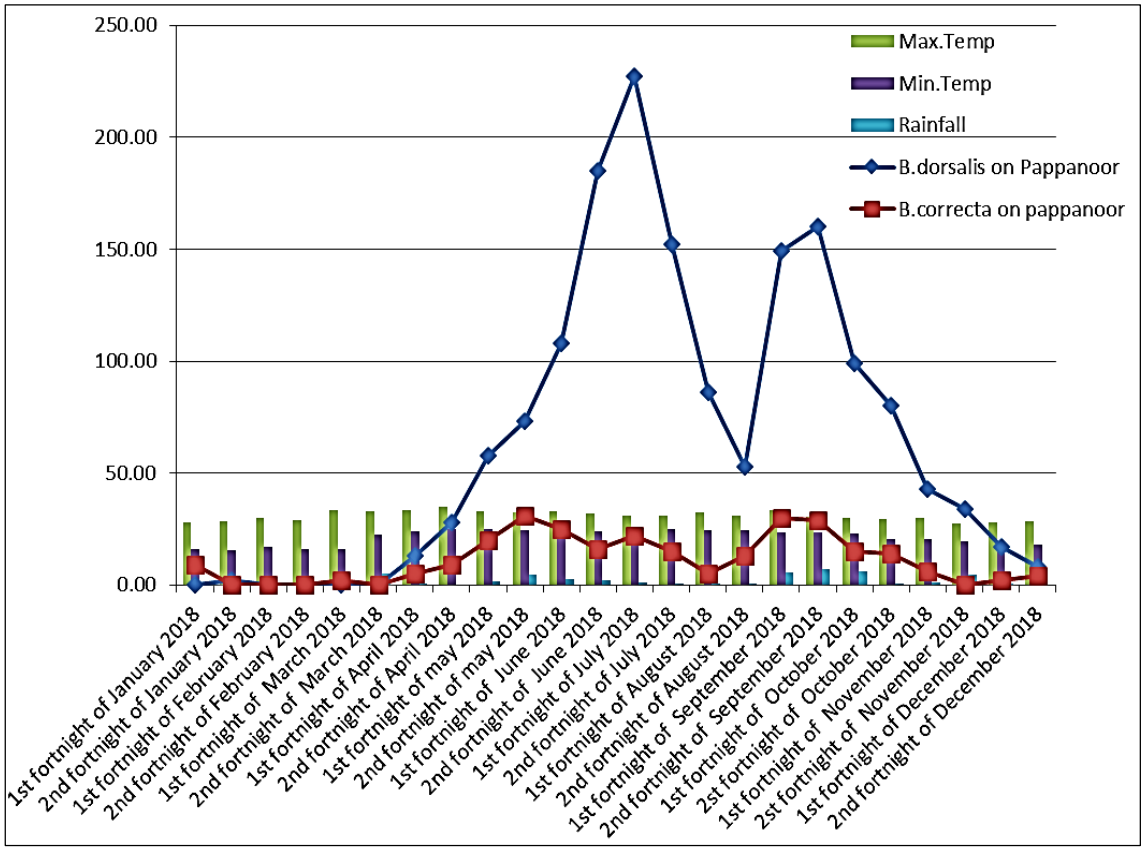

Fig 1: Population pattern of *B. dorsalis* and *B. correcta* in offseason mango orchard in relation to weather parameters (January-December 2018)

Conclusion

The populations of *B. dorsalis* and *B. correcta* observed in the target offseason fruiting mango ecosystem at Pappanoor in Krishnagiri district showed respective peaks during first fortnight of July (113.50 flies/trap/fortnight) and second fortnight of May (15.50 flies/trap/fortnight) The trap catches of *B. dorsalis* showed also significant positive correlation with minimum temperature (r = 0.637) but not correlated with maximum temperature and rainfall, with the three weather parameters together influencing the trap catches to the extent of 48 per cent. Trap catches of *B. correcta* showed significant positive correlation with minimum temperature (r = 0.656) and rainfall (r = 0.533), while not correlated with maximum temperature, with all three weather parameters to together influenced the trap catches to the extent of 53 per cent. The scope for additional locations/varieties wherein offseason fruiting is practiced in this region of Tamil Nadu is indicated as future need to evolve more robust local short term forecasting.

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