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S Vignesh
Research Scholar, Anbil
Dharmalingam Agricultural
College and Research Institute,
TNAU, Trichy, Tamil Nadu,
India

M Chandrasekaran
Assistant Professor,
(Entomology), Horticultural
College and Research Institute
for Women, Trichy, Tamil Nadu,
India

V Ambethgar
Director, Tamil Nadu Rice
Research Institute, TNAU,
Aduthurai, Tamil Nadu, India

S Jeeva
Professor and Head, Department
of Fruit Science Horticultural
College and Research Institute
for Women, Trichy, Tamil Nadu,
India

Species diversity and population dynamics of fruit flies in guava orchards

S Vignesh, M Chandrasekaran, V Ambethgar and S Jeeva

Abstract
Guava, *Psidium guajava* Linn. is well suited for cultivation under tropical and subtropical climatic conditions with the capability of withstanding adverse situation in various types of soil. In India, the total area under guava is 2.65 lakhs ha with the annual production of 4.05 million tons. The productivity of the guava fruit is mainly ravaged by various insect pests, among them the fruit flies, *Bactrocera* spp. are found to be the major devastating insect pest that causes extensive damage in the guava fruits and make it inconsumable and unmarketable. The variations in the abiotic factors are playing a vital role on the species complex and its population dynamics. The documentation on the population dynamics of fruit fly in guava and mango ecosystem provides both opportunities and challenges for planning and preceding the timely management practices. Keeping this in mind, this experiment was conducted to understand and explore the species complex and seasonal fluctuation of fruit fly in the guava ecosystem. The trap catches of fruit flies were taxonomically identified and categorized at species level. The observations made throughout the experimental period shown the prevalence of two species of fruit fly viz*., B. dorsalis* (Hendel) and *B. correcta* (Bezzi) in the guava orchards. The population dynamics of fruit flies expressed that, the peak incidence (110 no. /trap) in the month of August and the least trapping population of fruit fly activity (7.00 no. /trap) in the month of February. The activity of fruit flies was very minimum (10 no. /trap) in the guava ecosystem in December, January and February months of every year. In addition, the fruit flies activity was more in summer when compared with the seasons with high relative humidity and rainfall. The correlation analysis results revealed that, the *Bactrocera* spp. incidence is positively correlated with maximum, minimum temperature and negatively correlated with morning, evening relative humidity (RH) and rainfall.

Keywords: Guava, fruit fly, diversity, parapheromone, population dynamics, weather factors

1. Introduction

Guava (*Psidium guajava* Linn.) is one of the most important fruit crop belonging to the family Myrtaceae and popularly known it as "Poor man's apple" or "Apple of tropics". It is native to Central America and introduced in to India by Portuguese during the 17th century [1]. In India guava is the fourth largest commercially cultivated fruit crop, it contributes about 4.0 per cent of total fruit production. While comparing the productivity of guava with other nations; our country is poor in productivity due to the several insect pest problems. Guava is attacked by nearly 80 species of insect and mite pests; however only few of them have been noted as regular pest and causing serious damage [2]. The most important regular insect pest which attacking guava is fruit flies, *Bactrocera* spp. and it is potent enough to cause 60 to 80% damage [3]. The seasonal variations in the abiotic factors such as temperature, relative humidity, rainfall and other factors are ubiquitous and play a vital role on the species diversity and its population dynamics, seasonal variation in the strength of the population and its dispersal pattern. Hence, it is very much imperative and necessary to understand the environmental interaction with the fruit fly activity. The sound knowledge based on the seasonal database of insect population, species complex, seasonal abundance, dispersal pattern and changes in its population dynamics in relation to weather parameters paves way to determine and decision making, for the development and timely implementation of suitable organic or behavioral management technologies. The most important effective insect pest management involves the complete understanding of its behavioral nature with its existing environmental system. Keeping this in view, the present investigation was made to understand and explore the species complex, population dynamics and seasonal fluctuation of fruit fly in the guava orchards to forecast and recommend the need based suitable management measure to the farmers.

Corresponding Author:
S Vignesh
Research Scholar, Anbil
Dharmalingam Agricultural
College and Research Institute,
TNAU, Trichy, Tamil Nadu,
India

2. Materials and Methods

2.1 Location of the experiment

The experiment on the prediction of species diversity, seasonal abundance, dispersal pattern of fruit flies and its changes in population dynamics in relation to weather parameters in guava orchards was carried out during 2017-18 in the garden land farm of Horticultural College and Research Institute for women, Tamil Nadu Agricultural University, Tiruchirappalli, located between $10^0 45$'N latitude and $78^0 36$'E longitude at an altitude of 85m above the Mean Sea Level.

The experiment was conducted from 19th standard week of 2017 and periodical observations were taken till 18th standard week of 2018 at weekly interval.

2.2 Trapping of fruit flies on methyl eugenol traps

The trapping of fruit flies in the guava orchards planted with Lucknow 49 variety was made by keeping the parapheromone traps with methyl eugenol as fruit fly attractant. The white cylindrical jar type traps of about 15cm height and 10cm diameter with two holes of size about 5cm diameter in the sidewall, which act as entry point for fruit fly will be taken for monitoring the fruit fly activity in guava plantations. A wooden dispenser of size 4x2x1cm charged with methyl eugenol is hanged at the top of the trap using an iron wire act as an attractant for fruit fly. Top of the trap is entirely sealed and the perforated bottom is screwed with the jar trap. The perforations present in the bottom of the trap aids in drainage of the rain water. The traps were hanged in the guava trees randomly at a height of 1.5m above the ground level. The fruit flies trapped were collected at weekly interval for the species level identification and to assess the diversity with its variation in population dynamics. The position of the traps were inter changed at weekly interval while taking observation to avoid the positional effect.

2.3 Identification of fruit flies at species level

The fruit flies trapped were collected with care in a plastic container and taken to the laboratory for identification. The morphological character of every specimen was examined under the stereoscopic microscope with the aid of taxonomic keys [3]. After examining the specimens the fruit flies were assorted at species level and preserved systematically by using 75% ethanol for further studies.

2.4 Data analysis

The weather parameters viz., maximum temperature, minimum temperature, rainfall, morning and evening relative humidity during the experimental period were collected from the meteorological laboratory of Anbil Dharmalingam Agricultural College and Research Institute, TNAU, Trichy. The weather details recorded were summarized into weekly average and correlated with the weekly average of trap catches using spearman rank correlation to assess the influence of varied weather factors on the diversity and population dynamics of fruit flies.

3. Results and Discussions

The studies on the fruit fly species complex and its seasonal incidence in guava ecosystem revealed that, the incidence and spread of *Bactrocera* spp. in guava orchards throughout the experimental period (Table 1). The identification of trapped fruit flies at species level by using taxonomic keys clearly indicated that the diversity and population of *B.dorsalis* and *B.correcta* were more prevalent in guava ecosystem. The record on the presence of these two species and its high preference of guava fruits is well supported by the previous findings of [4]. Among the two species identified, the trapped population and its pattern of spread in varied months is more in case of *B. correcta* when compared with *B.dorsalis* but, the proportion between these two species is non-significant.

Table 1: Species diversity and population dynamics of *Bactrocera* spp. in the guava orchards (2017 – 18)

SMW	Date and Month	Trapped population of fruit flies			Meteorological parameters				
		Variety : Lucknow 49			Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
		B. correcta	*B. dorsalis*	Total	Max.	Min.	Mor.	Eve.	
19	07 May - 13 May	5.00	3.00	8.00	39.50	27.50	65.70	49.00	2.7
20	14 May -20 May	6.00	4.00	10.00	40.00	28.20	65.50	38.80	0.0
21	21 May -27 May	6.00	3.00	9.00	38.00	26.80	71.50	47.50	0.2
22	28 May - 03 June	5.00	2.00	7.00	37.70	27.50	70.00	41.80	0.0
23	04 June - 10 June	2.00	2.00	4.00	38.00	27.00	66.00	38.40	0.0
24	11 June - 17 June	4.00	3.00	7.00	39.00	27.40	65.20	37.20	0.0
25	18 June - 24 June	3.00	2.00	5.00	39.30	27.80	62.50	35.40	0.3
26	25 June - 01 July	2.00	1.00	3.00	37.40	27.70	63.70	39.00	0.0
27	02 July - 08 July	1.00	17.00	18.00	38.20	27.70	64.40	38.40	0.3
28	09 July - 15 July	5.00	21.00	26.00	37.40	28.60	67.20	40.00	0.0
29	16 July - 22 July	12.00	19.00	31.00	37.40	26.20	63.40	35.50	0.0
30	23 July - 29 July	4.00	11.00	15.00	39.70	28.40	63.20	33.20	0.0
31	30 July - 05 Aug.	12.00	12.00	24.00	38.00	27.70	73.10	43.80	6.1
32	06 Aug. - 12 Aug.	8.00	11.00	19.00	36.60	26.90	78.00	44.20	12.1
33	13 Aug. - 19 Aug.	12.00	12.00	24.00	34.90	24.80	81.20	46.10	10.2
34	20 Aug. - 26 Aug.	16.00	6.00	22.00	34.70	25.70	70.20	42.10	0.0
35	27 Aug. - 02 Sept.	14.00	7.00	21.00	35.70	26.00	76.40	47.80	0.3
36	03 Sept. - 09 Sept.	1.00	4.00	5.00	35.70	24.80	85.50	51.00	5.8
37	10 Sept. - 16 Sept.	11.00	5.00	16.00	34.50	24.50	88.70	54.20	5.4
38	17 Sept. - 23 Sept.	17.00	3.00	20.00	34.70	25.00	76.20	44.20	4.4
39	24 Sept. - 30 Sept.	10.00	5.00	15.00	34.60	24.30	82.50	47.50	11.1
40	01 Oct. - 07 Oct.	19.00	10.00	29.00	35.40	25.10	82.40	51.40	1.4
41	08 Oct. - 14 Oct.	4.00	4.00	8.00	34.50	24.50	90.40	60.70	4.9
42	15 Oct. - 21 Oct.	2.00	2.00	4.00	33.90	25.20	85.00	59.10	0.3

| 43 | 22 Oct. - 28 Oct. | 2.00 | 2.00 | 4.00 | 34.40 | 25.00 | 85.90 | 56.60 | 7.2 |
44	29 Oct. - 04 Nov.	13.00	5.00	18.00	30.70	24.20	91.10	71.80	2.5
45	05 Nov. - 11 Nov.	0.00	1.00	1.00	30.60	23.10	90.60	71.60	1.7
46	12 Nov. - 18 Nov.	1.00	1.00	2.00	32.90	23.40	90.60	66.60	0.0
47	19 Nov. - 25 Nov.	2.00	2.00	4.00	32.60	23.90	92.90	61.90	1.6
48	26 Nov. - 02 Dec.	3.00	3.00	6.00	29.60	23.10	89.70	80.70	0.2
49	03 Dec. - 09 Dec.	5.00	2.00	7.00	30.90	24.10	89.60	66.60	0.0
50	10 Dec. - 16 Dec.	0.00	0.00	0.00	30.90	24.10	89.60	63.30	0.0
51	17 Dec. - 23 Dec.	2.00	1.00	3.00	29.40	21.70	76.00	65.40	0.7
52	24 Dec. - 31 Dec.	0.00	0.00	0.00	29.80	20.60	76.40	57.40	0.0
1	01 Jan. - 07 Jan.	0.00	1.00	1.00	31.00	20.20	88.70	50.30	0.0
2	08 Jan. - 14 Jan.	1.00	1.00	2.00	30.90	20.20	90.10	63.00	1.3
3	15 Jan. - 21 Jan.	3.00	2.00	5.00	31.40	18.40	93.40	63.30	0.0
4	22 Jan. - 28 Jan.	2.00	1.00	3.00	31.60	19.10	90.60	51.30	0.0
5	29 Jan. - 04 Feb.	2.00	2.00	4.00	31.60	18.60	87.10	46.40	0.0
6	05 Feb. - 11 Feb.	0.00	0.00	0.00	31.70	18.40	85.30	47.40	0.0
7	12 Feb. - 18 Feb.	0.00	0.00	0.00	32.80	22.10	88.60	48.60	0.0
8	19 Feb. - 25 Feb.	2.00	1.00	3.00	31.60	19.10	89.10	43.90	0.0
9	26 Feb. - 04 Mar.	0.00	0.00	0.00	34.00	22.40	85.30	44.90	0.0
10	05 Mar. - 11 Mar.	4.00	1.00	5.00	34.30	21.80	85.30	37.70	0.0
11	12 Mar. - 18 Mar.	3.00	2.00	5.00	33.00	23.90	84.7	57.00	0.0
12	19 Mar. - 25 Mar.	2.00	2.00	4.00	34.00	23.80	83.0	44.30	0.0
13	26 Mar. - 01 Apr.	4.00	0.00	4.00	36.40	25.80	80.0	55.30	0.0
14	02 Apr. - 08 Apr.	0.00	0.00	0.00	37.30	26.00	81.1	42.30	0.0
15	09 Apr. - 15 Apr.	6.00	2.00	8.00	37.50	26.60	82.6	44.60	0.0
16	16 Apr. - 22 Apr.	11.00	7.00	18.00	38.40	27.10	82.3	43.10	0.0
17	23 Apr. - 29 Apr.	8.00	7.00	15.00	40.00	27.90	81.4	43.00	0.0
18	30 Apr. - 06 May.	9.00	7.00	16.00	40.10	28.10	78.0	43.00	0.0

*SMW – Standard Meteorological Week

The collective population trapped per month irrespective of species expressed that the maximum population and incidence was occurred in the months of August (110 flies/trap) and July (90 flies/trap). It was followed by the months of April (57.00), September (56.00), October (45.00), May (34.00) and November (31.00). The population of fruit flies was minimum *i.e.*, < 20 flies/trap/month in the months of March, June, December and January, in particular the incidence was very poor (7 flies/trap/month) in February. Considering the species wise average peak population trapped/trap/week, *B. correcta* was noticed more in the month of August; interestingly *B. dorsalis* was more prevalence in July. In general, both the species are very minimum in population, abundance and its spread in the months of December, January and February (<2flies/trap/week). The observation made during the experimental period clearly indicates that the activity of fruit flies was very minimum in the guava ecosystem in December, January and February months of every year. These observations on the maximum activity of *B. correcta* in August and *B. dorsalis* in July and poor population strength in February are also in consonance with the findings of [5] in mango. The same kind population dynamics of fruit fly in guava was registered and reported [6] and mentioned that the peak activity of *B. correcta* in the month of July at Tiruchirapalli. The documentation of maximum activity from the mid of July to August with respect to the species *B. zonata* at Uttar Pradesh strengthens the current record [7]. Hence, the results clearly indicated and confirmed that activity of fruit flies was maximum in the month of July to September in guava eco system irrespective of its species complex.

Table 2: Seasonal incidence of *Bactrocera spp.* during 2017 – 2018

Month (as per SMW)	Mean fruit fly population trapped / trap		
	Collective Population	B. correcta	B. dorsalis
May'17	34.00 (8.50)*	22.00 (5.50)	12.00 (3.00)
June	19.00 (4.75)	11.00 (2.75)	8.00 (2.00)
July	90.00 (22.5)	22.00 (5.50)	68.00 (17.00)
August	110.0 (22.0)	62.00 (12.4)	48.00 (9.60)
September	56.00 (14.0)	39.00 (7.80)	17.00 (3.40)
October	45.00 (11.5)	27.00 (6.75)	18.00 (4.50)
November	31.00 (6.20)	19.00 (3.80)	12.00 (2.40)
December'17	10.00 (2.50)	7.00 (1.75)	3.00 (0.75)
January'18	11.00 (2.75)	6.00 (1.50)	5.00 (1.25)
February	7.00 (1.75)	4.00 (1.00)	3.00 (0.75)
March	18.00 (3.00)	13.00 (2.16)	5.00 (1.25)
April'18	57.00 (11.4)	34.00 (6.80)	23.00 (4.60)

*Figures with in parentheses are average population/trap/week

The seasonal variations in the environmental abiotic factors such as temperature, relative humidity, rainfall and other factors are ubiquitous and play a vital role on the species complex and its population dynamics, seasonal variation in the strength of the population and its dispersal pattern. Hence, it is very much imperative and necessary to understand the environmental interaction with the fruit fly activity. The results on the correlation analysis of trapping population with the weather factors clearly indicated the influence of meteorological factors on the spread, diversity and abundance of fruit flies in varied climatic conditions under guava ecosystem (Fig.1).
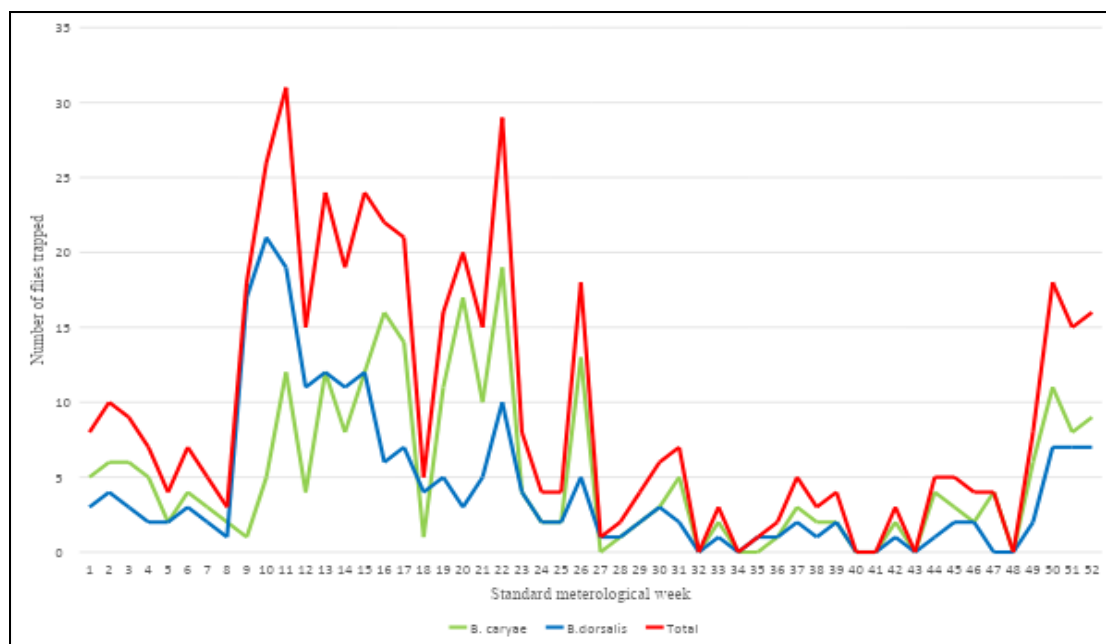
Fig 1: Seasonal incidence of fruit flies in the guava orchards

The correlation of weekly trap catch with weather parameters shows significant positive correlation with maximum (0.433) and minimum (0.507) temperature, contrastingly the negative correlation was noticed with morning RH (-0.383), evening RH (-0.330) and rainfall (-0.332). Among the *Bactrocera* species recorded, *B. dorsalis* shown the tendency of positiveness in spread and multiplication by increasing 0.50 units and 0.45 units towards the every one unit increase in maximum temperature and minimum temperature respectively, when compared with *B. correcta* (0.38-0.30 units) (Table 3).

Table 3: Correlation of weather parameters with the trap catch of fruit flies in guava orchards

Parameters	*B. correcta*	*B. dorsalis*	Total
Temperature (Max.)	0.303	0.448	0.433
Temperature (Min.)	0.378	0.501	0.507
RH (Morning)	-0.208	-0.456	-0.383
RH (Evening)	-0.196	-0.376	-0.330
Rainfall	-0.327	-0.248	-0.332

In general, throughout the year the relative humidity and rainfall shown a negative correlation and brings down the population. The pattern of spread and its positive correlation with the temperature factor and negative correlation with the relative humidity and rainfall factors observed in this present investigation is in corroboration with [8] on *B. dorsalis* and *B. zonata*. The highest negative correlation was recorded in *B. dorsalis* with the morning RH (-0.456). The trend shown towards the positive correlation of fruit fly population with the maximum and minimum temperatures and negative correlation with relative humidity and rainfall [8]. The findings of [8] were slightly in contrast that maximum temperature alone positively correlated and minimum temperature shown negative correlation. The negative correlation trend of trap catches of fruit flies with relative humidity and rainfall in the present investigation was found to be in accordance [9] with respect to the species *B. zonata* and [7] in the mango ecosystem of western plain region of Uttar Pradesh. The overall trapping population obtained in the present investigation confirmed the occurrence of fruit flies in all the months of year with the

variation in species prevalence and population. The abundance of fruit flies in the few months of the year itself enough to cause the economic injury to the guava fruits [10] anddrastic loss to the farmers. Hence, it is concluded that, the continuous monitoring by trap catches in guava orchards may provide the valid information on the occurrence of fruit flies, its diversity, spread and abundance. The indication of occurrence ultimately helps the farmers to take up the necessary protection measures in time to maximize the yield with marketable and consumable fruits.

4. Conclusion

The most important quarantine insect pest fruit fly is present throughout the year in the guava orchards and the overall population was found to be more during the month of July to September. In Tiruchirappalli region, the prevalence of *Bactrocera* spp. were found in the order of *B. correcta* > *B. dorsalis* > *B. zonata*. The maximum activity of *B. correcta* was noticed during the month of July at the mean time peak activity of *B. dorsalis* was recorded in the August month. The activity of these three species of fruit flies was found to be meagre in the months of December to February. The influence of external weather parameters on the population of fruit flies shows that rainfall and humidity declines the fruit fly population, whereas the temperature ranging 27^0 – 34 ^{0}C tends to increase the population of fruit flies.

5. Acknowledgement

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