Original Research Article

Methyl eugenol (parapheramone) trapping system on diversity of fruit flies and influence of weather parameters on trap catches in mango and guava ecosystems

ABSTRACT

Studies on species diversity and influence of weather parameters on methyl eugenol (parapheramone) trap catches was carried out in mango and guava orchards in Coimbatore and Dindigul districts of Tamil Nadu from Standard Meteorological Week (SMW) 16 to SMW 25. Species diversity indices were calculated and the methyl eugenol trap catches were correlated with the weather parameters. The results revealed that four fruit fly species viz., Oriental fruit fly, *Bactrocera dorsalis* (Hendel), Guava fruit fly, *B. correcta* (Bezii), *B. caryeae* (Kapoor), and Peach fruit fly, *B. zonata* (Saunders) were attracted to the parapheramone methyl eugenol traps. Among them the population of B. dorsalis was higher in both mango and guava orchards of Coimbatore and Dindigul districts. The highest species diversity indices for fruit flies viz., Shannon H' (0.936) and Simpsons D' (0.593), evenness (0.468), and richness (0.482) were observed in guava orchard located in Coimbatore district, and minimum diversity indices Shannon H' (0.254), Simpsons D' (0.921), evenness (0.160), and richness (0.291) were observed in mango orchard located in Dindigul district. The maximum number of fruit flies was trapped in SMW 19 in mango orchards of both districts 134 and 145 flies/three traps, respectively. In Coimbatore district's guava orchard and Dindigul district's mango orchard, trap catches revealed a significant positive correlation with rainfall. The subsequent weather parameters like max. temperature, min. temperature, wind speed, and relative humidity, are either positively or negatively correlated with trap catches in mango and guava orchards. In multiple regression analysis, the maximum predictability was seen in mango orchard (75.54%) located in Coimbatore district and the minimum (66.68%) in mango orchard located in Dindigul district.

Keywords: Mango, guava, methyl eugenol, fruit fly, species diversity, weather factors.

1. INTRODUCTION

India is one of the leading producers of mango (*Mangifera indica*) and guava (*Psidium guajava*). So, for nearly 400, 80 insect and mite pests were infesting mango and guava respectively [1] and [2]. Among them, fruit flies of the genus *Bactrocera* (Diptera: Tephritidae) are one of the major pests infesting mango and guava, causing yield loss that varies between 40 to 70% depending on the mango variety and being potent enough to cause 60 to 80% damage in guava [3] at field level and make it inconsumable and unmarketable. They are also a major constraint on the export of fresh mango fruits to foreign countries. It is a significant pest with a great potential for invasion due to its vast host range, adaptability to a range of climates, and rapid reproduction rate. The family tephritidae includes more than 4000 species in 500 genera. Of the 4000 species known, 392 species

have been recorded in India [4], among which six to seven species are found infesting mango and guava fruits in India. They include *Bactrocera dorsalis*, *B. zonata*, *B. correcta*. Of them, *B. dorsalis*, commonly called the Oriental fruit fly, was earlier considered to be the most important and dominant species in Southern India but now in recent times *B. caryeae* was widespread in southern India, and mango and guava are the common commercial hosts of the *B. caryeae* [5].

Adult male flies of these species are attracted to the phenylpropanoid compound methyl eugenol (para-pheramone) and voraciously feed it [6], and it is converted into two main components, namely; (E)-coniferyl alcohol (E-CF) and 2-allyl-4,- 5-dimethoxyphenol (DMP), that are temporarily sequestered in the rectal gland of males that release them during courtship at dusk [7], which is present in over 450 species from 80 families spanning 38 plant orders that contain varying amounts of methyl eugenol in leaves, roots, stems, flowers, or whole plant extracts [8], and it is play an important role for and monitoring and mass trapping of fruit flies. Seasonal fluctuations in abiotic factors, including temperature, relative humidity, rainfall and wind speed are common and have a significant influence on the diversity of species, their occurrence. Understanding the relationship between the environment and fruit fly activity is therefore absolutely essential. The development and timely implementation of management technologies are made possible by 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. In light of this, the current investigation was made to comprehend the diversity of fruit fly species from the family Tephritidae, determine the species diversity and the influence of weather parameters on the total trap catches on methyl eugenol trap.

2. MATERIAL AND METHODS

2.1 Location of the experiment

The present study was carried out at mango orchards located at Madampatti, Coimbatore district, located between $10^0$96'N latitude and $76^0$86'E longitude and Amarapoondi, Dindigul district, located between $10^0$52'N latitude and $77^0$58'E longitude. Guava orchards located at Aalanthurai, Coimbatore district, located between $10^0$93'N latitude and $76^0$79'E longitude and Palaya Aayakudi, Dindigul district, located between $10^0$44'N latitude and $77^0$57'E longitude, from SMW 16 to SMW 25 of 2023.

2.2Trapping of fruit flies using methyl eugenol traps

The cylindrical jar-type trap of about 15cm height and 10cm diameter with four holes of about 20mm diameter in the sidewall, which act as entry points for fruit flies, will be used to trap the male fruit flies in the mango and guava orchards. The plywood dispenser block of size 4 x 2.5 x 1 cm was impregnated with a methyl eugenol formulation for about 24 hours. The plywood dispenser was hanged at the top of the trap using an iron wire act as an attractant for fruit fly. Three traps were hanged in the mango and guava trees randomly at a height of 1.5m above the ground level. The trapped male fruit flies were collected in the zip-lock cover at weekly intervals.

2.3 Identification and accessing the diversity indices for fruit fly mango and guava ecosystem.

The trapped and collected fruit flies were observed under stereo zoom light microscope for the identification at species level by using the dichotomous key developed by [9].

The diversity indices *viz.,* relative Density (%) = (No. of dividuals of one species / no. of individuals of all species) x 100; and alpha diversity quantifed using Simpson's diversity index (*SDI*) [10], Shannon-Wiener Index (*H'*) [11], Pielou's Evenness Index (*E1*) [12] and Margalef Richness Index (Mg) [13] and Dominance index were calculated.

Simpson's diversity index was calculated by using the formula D = Σ*n (n-1)/ N (N-1)*, where *n* = total number of organisms of a particular species and *N* = total number of organisms of all species.

Subtracting the value of Simpson's diversity index from 1, gives Simpson's Index of Diversity (SID). The value of the index ranges from 0 to1, the greater the value the greater the sample diversity.

Shannon-Wiener index *H'*= – Σ*Pi* ln (*Pi*), where *Pi = S / N*, where *S* = number of individuals of one species, *N* = total number of all individuals in the sample, *ln* = logarithm to base

Pielou's evenness index *E1=H'/ ln(S)*; *H'*= Shannon-Wiener diversity index, *S*= total number of species in the sample

Margalef Richness Index (Mg) is calculated as species number minus one divided by the logarithm of the total number of individuals. This program uses the natural logarithm. Mg = (S – 1)/ln N, where S is the total number of species recorded and N the total number of individuals summed overall S species.

Dominance index was calculated by using an formula) D = Σ$(n/N)^2$ *or* D = (Σn *(n-1))/N(N-1)*

2.4. Data analysis

Abiotic factors such as maximum temperature, minimum temperature, relative humidity, rain fall and wind speed during the study period were get form the Agro Climate Research Centre (ACRC), Directorate of Crop Management (DCM), Tamil Nadu Agricultural University (TNAU), Coimbatore. The number of fruit flies trapped per week was correlated with the weather parameters using Pearson's correlation.

Species diversity of the fruit flies, correlation coefficient and the multiple regression was analysed by using the R software 4.2.3

3. RESULTS AND DISCUSSION

3.1 Relative abundance and population dynamics of fruit flies

The present study reveals that four fruit fly species *viz., B. dorsalis, B. correcta*, *B. caryeae* and *B. zonata* were attracted to the parapheramone methyl eugenol traps. All the species belong to the genus *Bactrocera* under the tribe Dacini of the subfamily Dacinae. The results revealed that among the species *B. dorsalis* was found to be the dominant species, followed by *B. correcta, B. caryeae,* and *B. zonata* in mango and guava orchards of Coimbatore and Dindigul districts. A total of 641 and 502 flies were trapped in mango and guava orchards of Coimbatore district, respectively (Table 1). Out of 641 fruit fly trap catches in mango orchard of Coimbatore 85.65% flies were *B. dorsalis*, while the remaining 12.79%, 0.94%, and 0.62% were *B. correcta*, *B. caryeae*, and *B. zonata*, respectively (Fig 1). Similarly in guava orchard located at Coimbatore 72.51, 26.10, 1.00, 0.40 % of flies were identified as *B. dorsalis, B. corrceta*, *B. caryeae* and *B. zonata,* respectively (Fig 1). The study also documented that the fly captured in mango and guava orchards of Dindigul district were 950 and 179, respectively (Table 1). Among them 95.89, 4.00, 0.11 % were *B. dorsalis*, *B. correcta*, and *B. caryeae* in mango orchard (Fig 1). Further in the guava orchard of Dindigul district recorded 86.59,

12.85 and 0.56 % of trapped fruit flies were *B. dorsalis*, *B. correcta* and *B. zonata*, respectively (Fig 1).

Table 1: Abundance of fruit fly species collected from the mango and guava orchards

		Different species of fruit flies trap catches for 10 weeks				
District	**Orchard**	***B.dorsalis**	***B. correcta**	***B. zonata**	***B. caryeae**	***Total trap catches**
Coimbatore	Mango	549	82	4	6	641
	Guava	911	38	0	1	950
Dindigul	Mango	364	131	2	5	502
	Guava	155	23	0	1	179

**Cumulative mean of three traps*

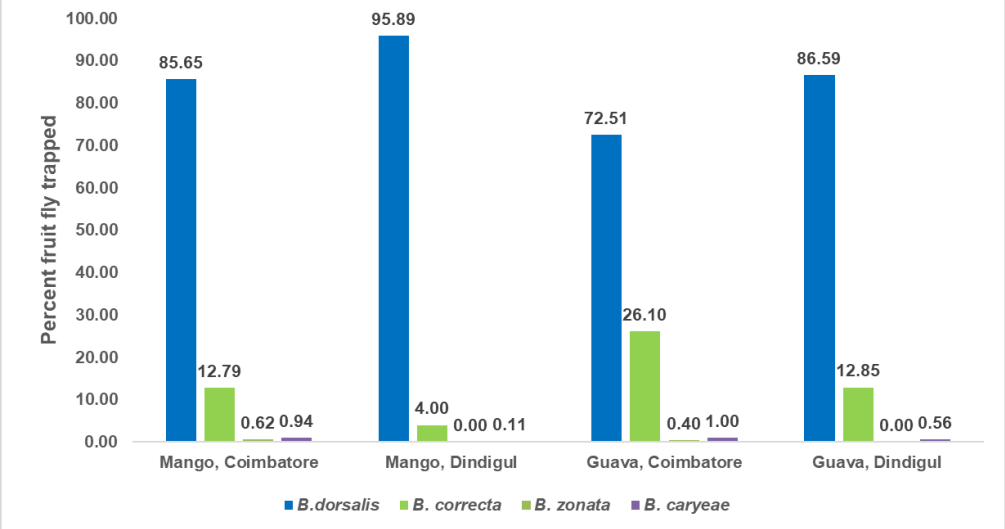

Fig 1: Relative density of fruit fly species trapped in mango and guava orchards

The above results revealed that *B. zonata* was absent in both mango and guava orchards in Dindigul district. The *B. correcta* population was maximum in the guava orchards when compared to the mango orchards and *B. dorsalis* was the dominant species in both the mango and guava orchards in Coimbatore and Dindigul districts. The results are in agreement with the findings of [14], [15] and [16]. They have reported that the *B. dorsalis* is the dominant species in the mango orchards in Tamil Nadu.

In the present study results also revealed that *B. dorsalis* is the dominant species in guava orchards and the results are in concurrence with [17] and [18]. They have reported the same in in Ranga Reddy district of Telangana and Ahmednagar district of Maharashtra respectively in guava orchard. On the contrary, [3] and [19] reported *B. correcta* is the dominant species in the guava orchards of Tamil Nadu and Karnataka

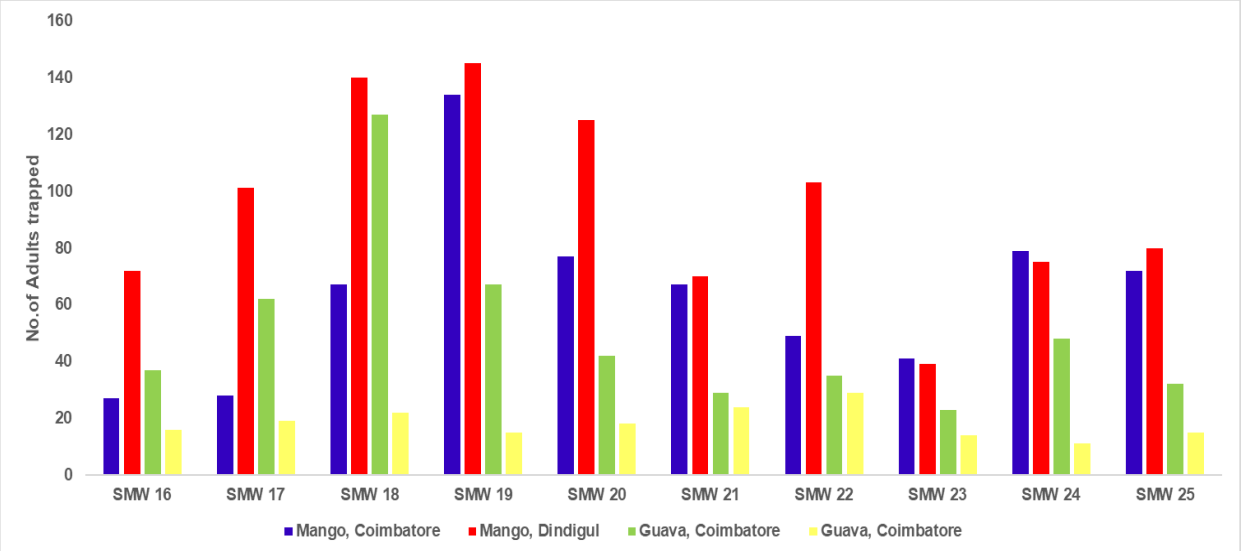

Fig 2: Population trend of fruit flies in mango and guava orchards.

The dynamics of fruit fly in methyl eugenol trap catches was observed between SMW (Standard Mean Week) 16 to SMW 25 during the fruiting season of mango and guava. In mango orchard of Coimbatore district, the lowest fruit fly populations were captured during SMW 16 (27 flies), and the highest populations were captured during SMW 19 (134 flies) (Fig 2). In mango orchard of Dindigul district the trapped fruit fly population was gradually increased from SMW 16 (72 flies) and it attains the maximum of 145 flies during SMW 19, there after the lowest flies trap catches was recorded (39 flies) in SMW 23 (Fig 2). In guava orchard of Coimbatore district, highest trap catches were began to rise from SMW 16 (37 flies) and the maximum of 127 flies trapped during SMW 18 and followed by SMW 19 (67 flies) onwards and least trap catches were observed during SMW 23 (23 flies) (Fig 2). Similarly, in guava orchard located at Dindigul district maximum number of fruit flies were trapped on SMW 22 (29 flies) and the least population of 11 flies trapped in SMW 24 (Fig 2). The methyl eugenol trap catches were differed at the orchard level, which may be due to different agro climatic factors, crop phenology and corresponding to fruiting period and fruit maturity.

3.2 Species diversity

Fruit fly diversity indices, richness, and evenness were computed. Guava orchard located in Coimbatore district had the highest Shannon index (H' = 0.936), followed by guava orchard in Dindigul district (H' = 0.602) and mango orchards of Coimbatore and Dindigul districts had the lowest Shannon index (0.471 and 0.254, respectively) (Table 2). The same degree of order was also seen in the species evenness. High Simpson's index of diversity (1-D) was found in guava orchard of Coimbatore district (SID = 0.406), followed by mango orchard of Coimbatore district (SID = 0.250), guava and (SID = 0.245) and mango (SID = 0.078) orchards of Dindigul district (Table 2).

The high Dominance index was found in mango orchards of both districts (0.750 and 0.789), when compared to the guava orchards (0.406 and 0.235) in Coimbatore and Dindigul District (Table 2). The species richness was high in the mango and guava orchards of Coimbatore districts (0.464 and 0.482), followed by guava orchard of Dindigul district (0.385) and the low species richness was observed in mango orchard located at Dindigul district (0.291) (Table 2).

High species diversity, evenness and was seen in the guava orchards in both districts when compared to mango orchards.

Table 2: Species diversity indices for trapped fruit flies in mango and guava orchard

Orchard	Diversity of fruitfly Species					
	Shannon-Weiner index (H)	Simpson's index (D)	Simpson's index of diversity	Evenness (E)	Dominance Index	Margalef Richness Index
Mango, Coimbatore	0.471	0.749	0.25	0.339	0.75	0.464
Mango, Dindigul	0.254	0.921	0.078	0.16	0.789	0.291
Guava, Coimbatore	0.936	0.593	0.406	0.468	0.406	0.482
Guava, Coimbatore	0.602	0.765	0.245	0.379	0.235	0.385

3.3 Influence of weather parameters on population dynamics of fruit fly species in mango and guava orchards

Studies were conducted to determine the correlation between methyl eugenol fruit fly trap catches and weather factors such as maximum temperature, minimum temperature, wind speed, rain fall, and relative humidity.

3.3.1. Correlation coefficient

The correlation analysis between the weather parameters and fruit fly trap catches in mango orchard located at Coimbatore district revealed that trap catches were positively correlated with rain fall (r=0.53), relative humidity (r=0.56) and wind speed (r=0.16), negatively correlated with max. temperature (r=-0.53) and min. temperature (r=-0.25). In guava orchard of Coimbatore district, the methyl eugenol trap catches have a positive correlation with rain fall (r=0.73), negatively correlated with the max. temperature (r=-0.03), min. temperature (r=-0.31), relative humidity (r=-0.17) and wind speed (r=-0.20). Further, in mango orchard of Dindigul district that trap catches were positively correlated with min. temperature (r=0.24), rain fall (r=0.67) and relative humidity (r=0.23), negatively correlated with max. temperature (r=-0.23) and wind speed (r=-0.57). Similarly, in guava orchard revealed that trap catches were positively correlated with min. temperature (0.28), rain fall (r=0.33) and relative humidity (r=0.10), negatively correlated with max. temperature (r=-0.07) and wind speed (r=-0.61).

The result suggested that the number of fruit flies trapped in mango and guava orchards could rise when rain fall and relative humidity raises. In guava orchard of Coimbatore district, at the end of 10^{th} week the relative humidity showed negative correlation with methyl eugenol trap catches. In the same experiment, up to 5^{th} week positive correlation was recorded between trap catches and relative humidity (r=0.34) after then from 6^{th} to 10^{th} week, negative correlation was recorded this may due to that the methyl eugenol content in the plywood dispenser was reduced after 5^{th} week and influenced reduction in the trap catches from 6^{th} week onwards. The results are in agreement with the [19] they stated that relative humidity and the rainfall are positively correlated and the maximum and minimum temperature are negatively correlated during the study period 2016 – 2017 in guava orchards. Similarly, [20] stated that the temperature had a positive correlation with the fruit

fly population at three of five locations studied and the other two location had a negative correlation with temperature, and the rainfall had a positive correlation with the population in three locations. The fruit fly population has positive correlation with rain fall, relative humidity and min. temperature and negative correlation with max. temperature [21]. According to [22] *B. dorsalis* in guava had significant positive correlation with minimum temperature and morning and afternoon relative humidity, but had significant negative correlation with maximum temperature. [23] reported that there is positive correlation between population build up and rainfall. There is positive correlation between wind speed and the trap catches [24].

Table 3: Population dynamics of *Bactrocera* spp. in the mango and guava orchard located at Coimbatore (Dt.)

SMW	Date and month	Total number of fruit flies trapped/week		Meteorological parameters				
		*Mango orchard	*Guava orchard	Temperature (^{0}C) Max.	Temperature (^{0}C) Min.	Wind speed (m/s)	Rain fall (mm)	Relative Humidity (%)
16	16 April - 22 Apr.	27	37	35.1	24.57	1.27	8.55	67.91
17	23 April - 29 Apr.	28	62	33.69	24.62	0.96	91.08	72.95
18	30April - 6 May	67	127	29.2	23.41	1.11	130.09	81.24
19	7 May- 13 May	134	67	29.75	24.13	1.17	158.69	84.46
20	14 May - 20 May	77	42	30.7	24.68	1.04	26.48	84.12
21	21 May - 27 May	67	29	29.35	24.23	1.03	36.68	86.92
22	28 May - 3 June	49	35	29.56	24.19	0.99	45.45	85.01
23	4 June - 10 June	41	23	28.78	23.79	1.31	57.7	86
24	11 June - 17 June	79	48	28.65	23.71	1.42	42.69	87.48
25	18 June - 24 June	72	32	28.83	23.46	1.31	31.92	86.18

**Cumulative mean of three traps*

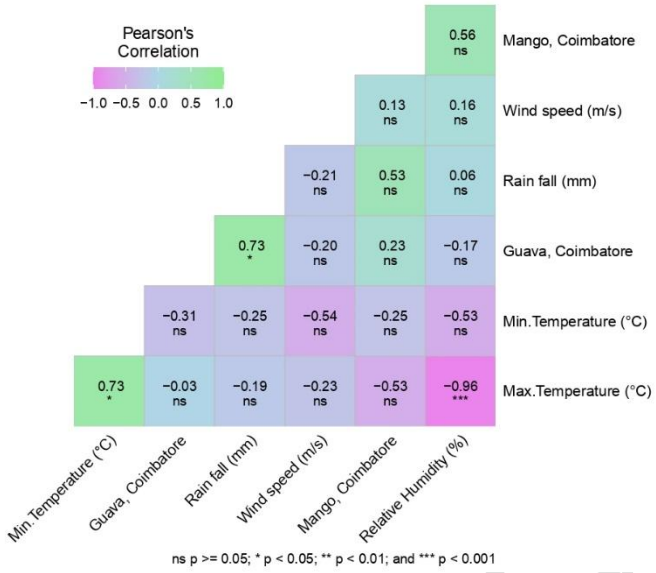

Fig 3: Effect of weather parameters on methyl eugenol trap catches in mango and guava orchard of Coimbatore districts

Table 4: Population dynamics of *Bactrocera* spp. in the mango and guava orchard located at Dindigul (Dt.)

SMW	Date and month	Total number of fruit flies trapped/week		Meteorological parameters				
		*Mango orchard	*Guava orchard	Temperature (^{0}C) Max.	Temperature (^{0}C) Min.	Wind speed (m/s)	Rain fall (mm)	Relative Humidity (%)
16	16 Apr. - 22 Apr.	72	16	37.34	23.23	1.63	2.11	48.21
17	23 Apr. - 29 Apr.	101	19	32.51	23.33	1.67	95.85	69.66
18	30April. - 6 May.	140	22	29.14	22.37	1.51	161.04	79.79
19	7 May. - 13 May.	145	15	30.43	22.65	2.26	78.46	81.2
20	14 May. - 20 May.	125	18	31.41	23.46	2.07	21.03	78.41
21	21 May. - 27 May.	70	24	31.42	22.69	2.19	24.08	77.73
22	28 May. - 3 June.	103	29	30.56	22.79	1.97	47.15	79.7
23	4 June. - 10 June.	39	14	29.97	22.39	3.32	25.23	80.51
24	11 June. - 17 June.	75	11	30.41	22.13	3.49	7.95	79.19
25	18 June. - 24 June.	80	15	29.84	21.76	2.8	22.99	79.76

**Cumulative mean of three traps*

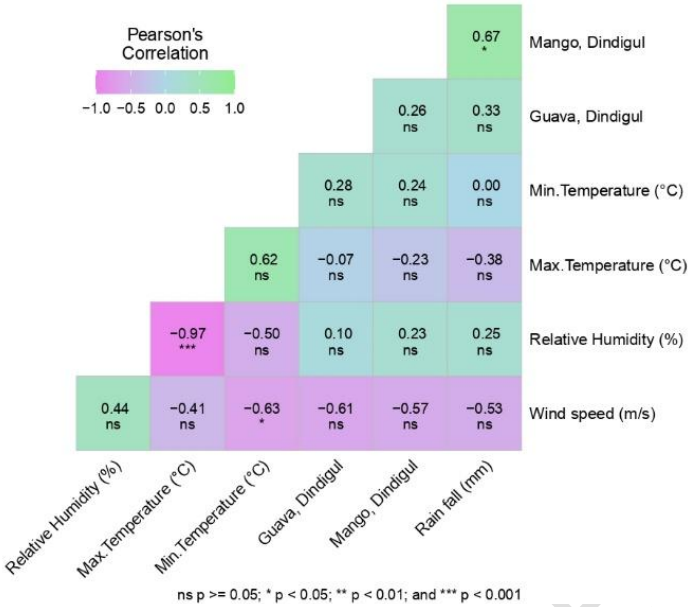

Fig 4: Effect of weather parameters on methyl eugenol trap catches in mango and guava orchard located at Dindigul (Dt.)

3.3.2. Multiple regression

The effect of various meteorological parameters on fruit fly trap captures was studied using multiple regression analysis. The equation's prediction for mango and guava orchards located in Coimbatore and Dindigul districts ranged from 75.54 percent to 66.88 percent. Mango orchard of Coimbatore had the best predictability in the regression model (75.54%), followed by guava orchard of Coimbatore (75.51), guava (68.02%) and mango (66.68%) orchards of Dindigul, with the lowest predictability (Table 5).

Table5: Multiple linear regression of methyl eugenol trap catches of fruit flies with weather parameters in mango and guava orchards

District	Orchard	Regression model	Regression coefficient (R^2)
Coimbatore	Mango	$Y = -1738.90 + 37.84\ x_1 - 23.57\ x_2 + 56.50\ x_3 + 0.53\ x_4 + 13.64\ x_5$	0.7554
	Guava	$Y = 1567.28 - 25.38\ x_1 + 0.96\ x_2 - 45.53\ x_3 + 0.28\ x_4 - 8.96\ x_5$	0.7551
Dindigul	Mango	$Y = -959.76 + 21.74\ x_1 - 11.77 x_2 - 21.51\ x_3 + 0.44\ x_4 + 6.62\ x_5$	0.6688
	Guava	$Y = 145.83 - 2.71\ x_1 - 0.19 x_2 - 11.35\ x_3 - 0.09\ x_4 - 0.102\ x_5$	0.6802

x1 = maximum temperature; x2 = minimum temperature; x3 = wind speed; x4 = rainfall; x 5 = relative humidity; Y = number of fruit flies

4. CONCLUSION

The present study revealed that, in mango and guava orchards located in Coimabtore and Dindigul districts, the prevalence of *Bactrocera* spp. was found in the order *B. dorsalis* > *B. correcta* > *B. Caryeae*> *B. zonata*. The highest number of fruit flies were trapped in SMW 18

and SMW 19. A high level of species diversity and richness was present in the guava orchards of both districts. The influence of weather parameters on the methyl eugenol trap catches shows that an increase in rainfall and relative humidity will increase the trap catches.

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