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Magnitude of melon fruit fly, *Bactrocera cucurbitae* (Coquillett) in watermelon ecosystem in Tamil Nadu

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Abstract
Study on population magnitude of melon fruit fly, *Bactrocera cucurbitae* (Coq.) in watermelon was done during November 2018 to January 2019 in three districts of Tamil Nadu using cue-lure traps. The traps were arrayed at 45 cm height in the experimental sites. Significantly higher mean population was recorded in Dharmapuri (17.57±0.78) followed by Tiruvannamalai (16.14±0.79) and Kanchipuram districts (13.8 ±0.84). Irrespective of the location, highest mean population was found during December while lowest population was observed during last week of January. Negative correlation was obtained between temperature and fruit fly population, while rainfall and relative humidity positively correlated with fruit fly capture in all the three experimental sites. Higher population level observed during December month coincided with peak flowering period of watermelon crop. Results reveal that low temperature and availability of flower, influence population level and hence planting period can be manipulated to escape peak population period of fruit fly.

Keywords: Fruit fly, water melon, temperature, rainfall, population

Introduction
Water melon (*Citrullus lanatus*) is widely cultivated in warmer parts of the world. It has been grown widely on both sides of the equator. It contributes to about 5.6 per cent of the total vegetables production of India. Among the countries, China ranks first in production with 55 per cent world production (72.943 MT).

Insect pests are most important factors, and are responsible for low yield and poor quality of fruits and vegetables. Among them, fruit flies are considered to be an important quarantine pest that may cause even up to 100 per cent yield losses in cucurbits (Dhillon *et al*., 2005) [5]. Worldwide, 4000 species of fruit flies are present (Norborn *et al*., 1998), of which about 5 per cent of fruit fly species occur in India (Ramani, 1998) [15]. Twenty- one species of fruit flies have been documented from the Andaman and Nicobar Islands of India (Ranganath and Veenakumari, 1999; Ramani, 1998) [17, 15].

A number of fruit fly species have been reported damaging cucurbit fruits which include *Bactrocera cucurbitae* (Coquillett), *B. ciliates* (Loew), *B. diversus* (Coquillett), *B. zonatus* (Saunders), *B. parvulus* (Hendal), *B. tau* (Walker) and *Myripardalis pardalina* (Bigot) (Kapoor, 1970) [9]. In Dacinae subfamily, the genus *Bactrocera* is of great importance as it includes economically important species such as *B. cucurbitae* in watermelon. The gravid females of genus *Bactrocera* oviposit on physiologically mature fruit except watermelon crop where it oviposits on 7 to 10 days old fruit. After emergence the larvae feed on internal edible content of fruit causing decay and secondary infection. Maggots pass through three larval instars and at the end of third instar stage move into the soil to pupate. The maggots can jump from the fruit to the ground to find a suitable place for pupation.

Pheromone and para-pheromone traps are efficiently used to investigate population magnitude of fruit flies in different regions of the world (Marwat and Baloch, 1986; Gillani *et al*., 2002) [13, 6]. Cue-lure traps provide a simple and effective way to study population densities of *B. cucurbitae* which is important for the successful pest management (Alyokhun *et al*., 2000) [2].

The impact of environmental factors (such as temperature, relative humidity and rainfall) directly associated with population densities of melon fruit fly were studied using cue-lure traps. Fruit fly species captured using cue-lure tempted traps were positively related with

factors such as temperature, relative humidity and rainfall (Lee *et al*., 1997; Jha *et al*., 2007) [11, 7]. Keeping in mind the commercial consequence of cucurbit vegetables and the losses sustained by melon fruit fly incursion, it was vital to study the population fluctuation of melon fly, *Bactrocera cucurbitae* and impact of ecological factors on its capture to follow sustainable pest management strategy in watermelon ecosystem, with which idea this study was planned.

Materials and Methods

Field experiments were conducted for monitoring the population abundance of melon fruit fly, *B. cucurbitae* in watermelon in Dharmapuri, Tiruvannamalai and Kanchipuram districts of Tamil Nadu. Effects of abiotic factors such as temperature, relative humidity and rainfall and influence of flower availability on population density of melon fly were studied. An area of 0.8 hectare was selected in each location for observing the *B. cucurbitae* population. The hybrid watermelon crop was raised following standard package of practice, at a spacing of 1.2 m× 0.6 m (row × plant).

Cue-lure traps made of plastic jars that measured 14cm in length and 10cm in diameter were used for fly trapping. Inside each trap, a small piece of wood (4cm length) impregnated with cue lure is hung. The traps had 4 holes on the surrounding to allow the flies to enter inside. A small perforated hole on the top of trap allows the cue-lure chemical to infuse into air. The traps were placed at 45 cm height in all the locations during the study period from 21.11.2018 to 26.1.2019. The captured male flies were collected and counted on daily basis.

Meteorological data and statistical analysis

The weather data on maximum and minimum temperature, relative humidity and rainfall were collected from the Agro Climate Research Centre of Tamil Nadu Agricultural University, Coimbatore corresponding to the study period.

All statistical analysis were done with the help of SPSS software version 16.0. Statistical analyses were calculated using one-way of variance ANOVA for different parameters followed by Tukey's test Post Hoc HSD test for significance of data.

Results

The present investigations on population dynamics of melon fly (*B. cucurbitae*) in different locations of Tamil Nadu revealed that the melon fruit fly (*B. cucurbitae*) was a predominant pest in all watermelon growing ecosystems under study. The per day highest mean number of melon flies was recorded in Dharmapuri district (17.57 ±0.78) followed by Tiruvannamalai and Kanchipuram (16.14 ± 0.79, 13.85 ± 0.84) districts respectively.

The maximum and statistically significant incursion of *B. cucurbitae* was recorded during first three weeks of December (13.85± 0.84 to 17.57 ±0.78) (Table 1, 2 and 3) in all the three districts studied and gradually it declined during January. The lowest mean population of *B. cucurbitae* was recorded in all the three study sites during the last week of January during which period, the temperature ranged from 18.10 to 33.06, 24.09 to 30.44 and 22.62 to 31.05 (Table 1, 2 and 3). Thus, significant negative correlation was recorded between temperature (minimum and maximum) and *B. cucurbitae* population whereas, rainfall (mm) and relative humidity (%) positively correlated with fruit fly capture at all the experimental sites under study (Table 4). During the peak flowering window that lasts for around 20 days, the population ranged from minimum 7.42 ± 0.9 to maximum of 17.57 ± 0.7 (Table 5). The study revealed that flower availability after flower initiation period had higher positive correlation with population level (0.7823).

Discussion

The present study confirmed that population intensities of *B. cucurbitae* fluctuated due to several reasons throughout the cropping period and among them ecological factors (temperature, relative humidity and rainfall) and availability of food during cropping period played an important role. This study showed the activity of *B. cucurbitae* species throughout the cropping period. The population of *B. cucurbitae* started to increase from 1st week of December until third week where it reached the peak and gradually started to decline during 1st week of January. In Dharmapuri Dt, temperature ranged from 19.5 to 32.2°C during December. The minimum temperature that prevailed in the district may favoured higher population when compared to other districts, which was proved by the negative correlation between temperature and fruit fly population. Similarly, Abu and Srivastava (2004) [1] reported that fruit fly positively correlates with maximum and minimum temperature and negatively correlates with maximum and minimum relative humidity and rainfall. Contrastingly, Tan and Serit (1994) [18] found that rainfall, temperature, relative humidity and wind speed had no significant correlation with *B. doraslis* male population parameters in Penang Island, Malaysia. Babu and Viraktamath (2003) also stated that *B. dorsalis* and *B. cucurbitae* populations had non significant correlation with temperature, rainfall and relative humidity in northern Karnataka.

Ye (2001) [20] reported high abundance of *B. cucurbitae* from May to November each year in Yunnan province of China. In contrast Mahmood and Ullah (2007) [12] reported that population intensity of *B. cucurbitae* was high in July to October. Khan *et al.* (2003) [10] reported rainfall as the most important factor among all the abiotic factors that determined the fruit fly population in Pakistan.

The fruit fly population started declining during first week of January and reached lowest during the last week of January, when temperature started raising. But Ramasamy (1989) and Joshi *et al*. (1995) observed that population of fruit fly (*B. cucurbitae*) was less during January when collected using cue-lure baited traps in bitter gourd field.

Correlation between rainfall and melon fly capture showed a less positive relationship with the melon fly capture in watermelon ecosystem in all the experimental areas. Vargas *et al*. (2003) also stated that relative humidity and rainfall are crucial factors which impacts *B. cucurbitae* incidence. The rainfall and relative humidity favours for development of fruit fly.

The availability of flowers after the flower initiation period correlated positively with the population. Flower availability was more on 10th day after flower initiation and this supported the adult flies which inturn reflected on the population. Fruit fly adults prefer water melon flower as their nectar source (Courtice, 1984) [4].

Conclusion

In the present study, watermelon was found to be a susceptible host for *B. cucurbitae* in terms of infestation. High population of *B. cucurbitae* was observed from 1st week of December with population ranging from 13. 85 ± 0.84 to

17.57 ± 0.78 and gradually decreased from 1st week of January during which the population ranged from 4.00 ± 0.40 to 6.42 ± 0.52. It was found that temperature had negative correlation while relative humidity and rainfall positively correlated with population buildup of *B. cucurbitae* in watermelon ecosystem in Tamil Nadu. Results reveal that low temperature and flower availability influence population level and hence planting period of watermelon can be manipulated to escape incidence by fruit fly.

Table 1: Population density of *B. cucurbitae* during November 2018 to January 2019 in relation to weather parameters in Dharmapuri district of Tamil Nadu

Month/Year	Week	Mean population of fruit fly	Temperature (°C)		Relative humidity (%)	Rainfall (mm)
			Min.	Max.		
November 2018	1st week	13.14±1.01def	20.28±0.68ab	30.28±0.78ab	75.43±2.125e	2.45±0.92a
	2nd week	12.71±1.26cdef	18.49±0.87a	29.53±0.67a	74.94± 2.77e	2.96±1.83a
	3rd week	7.42±0.92ab	18.47±0.38ab	30.14±0.45ab	73.63±2.366de	1.06±0.59a
	4th week	8.28±0.86abcd	18.91±0.37abc	31.47±0.21abc	68.05±1.60cde	0.05±0.42a
December 2018	1st week	17.57±0.78f	17.09±0.42abc	31.07±0.69abc	60.06±2.76abc	0.00±0.00a
	2nd week	16.00±1.15ef	18.29±0.48abc	31.39±0.63abc	64.60±2.12bcd	0.16±0.09a
	3rd week	13.57±1.36bcdef	16.18±1.08ab	30.67±0.38ab	58.77±1.95ab	0.12±0.08a
	4th week	11.14±1.35bcde	18.84±0.26abc	31.20±0.33abc	54.24±1.60a	0.00±0.00a
January 2019	1st week	8.14±1.05abcd	19.51±0.31bc	31.96±.08bc	51.09±1.42a	0.00±0.00a
	2nd week	7.57±0.922abc	21.83±0.41bc	32.07±0.26bc	51.32±1.37a	0.00±0.00a
	3rd week	8.00±1.09abcd	19.28±0.44bc	32.22±0.39bc	57.97±0.93ab	0.20±0.13a
	4th week	5.85±0.96a	18.10±0.42d	33.06±0.42d	52.44±0.92a	0.00±0.00a

Table 2: Population density of *B. cucurbitae* during November 2018 to January 2019 in relation to weather parameters in Tiruvannamalai district of Tamil Nadu

Month/Year	Week	Mean population of fruit fly	Temperature (°C)		Relative humidity (%)	Rainfall (mm)
			Min.	Max.		
November 2018	1st week	12.71±1.59bcd	27.27±0.27bc	34.05±0.31b	67.62±2.90a	0.00±0.00a
	2nd week	12.00±1.44abcd	27.71±0.80bcd	34.24±0.92b	68.10±5.51b	0.00±0.00a
	3rd week	9.14±1.28abc	28.98±0.43bcd	35.91±0.50bc	75.70±1.09b	0.00±0.00a
	4th week	8.00±1.74ab	29.47±1.28bcd	36.17±0.21bc	55.84±8.05b	0.00±0.00a
December 2018	1st week	16.14±0.79d	23.70±0.18bcd	34.64±1.17b	69.31±1.61b	0.00±0.00a
	2nd week	14.85±1.05cd	22.55±0.23bcd	36.75±0.34bc	64.70±0.55b	0.16±0.09a
	3rd week	13.14±0.88bcd	22.57±0.35bcd	32.85±0.19c	75.80±6.59b	0.12±0.08a
	4th week	11.85±1.26abcd	21.95±0.29bcd	34.75±0.43c	63.68±4.05b	0.00±0.00a
January 2019	1st week	8.28±1.32ab	23.81±0.49a	30.72±1.42a	67.80±6.06b	0.00±0.00a
	2nd week	8.57±1.17ab	24.92±0.79cd	29.81±0.79a	64.32±2.10b	0.00±0.00a
	3rd week	8.71±0.96ab	23.92±0.29bcd	28.92±0.29a	63.74±8.94b	0.20±0.13a
	4th week	6.42±0.52a	24.09±0.42d	30.44±0.27a	68.83±0.72b	0.00±0.00a

Table 3: Population density of *B. cucurbitae* during November 2018 to January 2019 in relation to weather parameters in Kanchipuram district of Tamil Nadu

Month/Year	Week	Mean population of fruit fly	Temperature (°C)		Relative humidity (%)	Rainfall (mm)
			Min.	Max.		
November 2018	1st week	12.00±0.89bc	20.02±0.49ab	30.44±0.41a	65.25±1.16a	0.41±0.27a
	2nd week	11.28±1.30bc	24.00±0.66bcde	35.14±0.72bc	65.55±3.75a	0.00±0.00a
	3rd week	10.00±1.15bc	27.44±0.42e	37.60±0.71d	59.42±3.50a	0.50±0.36a
	4th week	9.85±1.01bc	26.51±0.41e	35.34±0.70bc	64.62±2.35a	0.423±0.22a
December 2018	1st week	13. 85±0.84c	25.91±0.43de	35.04±0.57bc	72.30±1.97a	0.35±0.28a
	2nd week	13.42±0.76c	25.25±0.39de	34.80±0.22bc	71.48±1.56a	0.50±0.36a
	3rd week	11.42±0.89bc	22.05±0.72abc	32.78±0.53ab	65.25±1.16a	0.42±0.22a
	4th week	11.14±1.24bc	18.82±1.76a	32.91±1.00ab	61.55±3.74a	2.21±1.31a
January 2019	1st week	8.28±1.32ab	24.74±0.50cde	35.15±0.48bc	61.95±3.14a	0.00±0.00a
	2nd week	7.71±1.18ab	20.81±1.65abc	35.02±0.44bc	61.55±3.74a	0.00±0.00a
	3rd week	7.71±0.60ab	21.67±1.32abc	33.88±0.39c	59.42±3.52a	1.00±1.44a
	4th week	4.00±0.40a	22.62±0.67de	31.05±0.26a	64.62±2.35a	0.42±0.22a

Table 4: Pearson's correlation between weather parameters (temperature, relative humidity and rainfall) and *B. cucurbitae* population

Location	Weather parameters (Pearson's Correlation)			
	Temperature (°C)		Relative humidity (%)	Rainfall (mm)
	Min.	Max.		
Dharmapuri	-0.5323	-0.0692	0.3972*	0.2487*
Tiruvannamalai	-0.5778	-0.0513	0.4805*	0.2653*
Kanchipuram	- 0.5429	-0.0598	0.4269*	0.3160 *

Table 5: Influence of flower availability and fruit size on fruit fly population

Days from flower initiation	No. of Flowers/ Plant	Mean population of fruit fly
Day of flower initiation	2.10	7.42±0.92
3rd day	2.30	8.28±0.86
5th day	3.05	16.00±1.1
10th day	4.85	17.57±0.7
15th day	3.85	13.57±1.36
20th day	1.8	11.14±1.35

Result: Highly correlates with 10th day after flower initiation (0.7823)

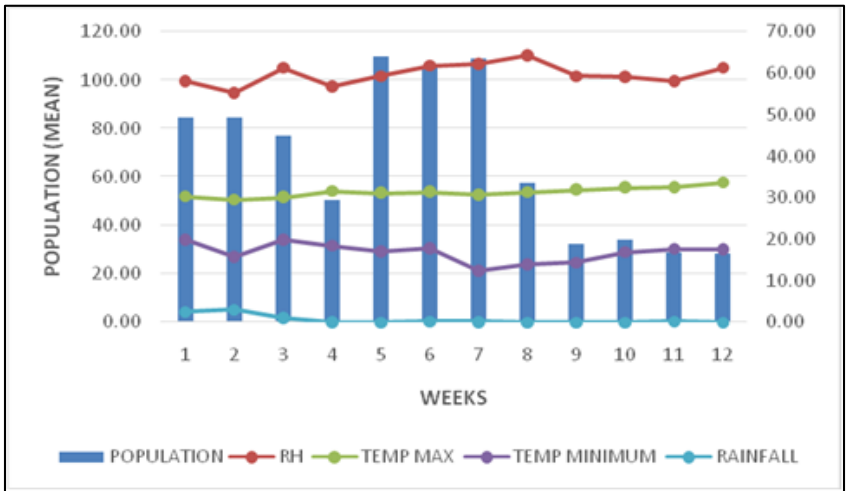

Fig 1: Effect of weather parameters on population magnitude of *B. cucurbitae* in watermelon-ecosystem in Dharmapuri district

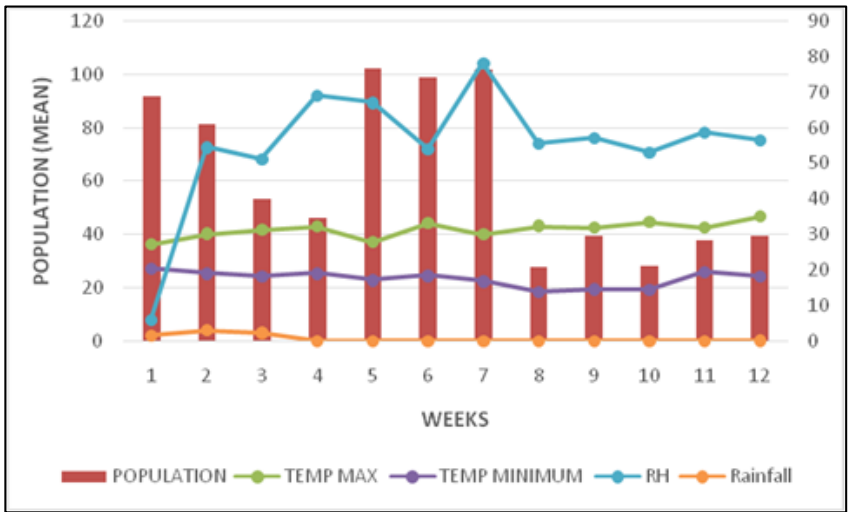

Fig 2: Effect of weather parameters on population magnitude of *B. cucurbitae* in watermelon-ecosystem in Tiruvannamalai district

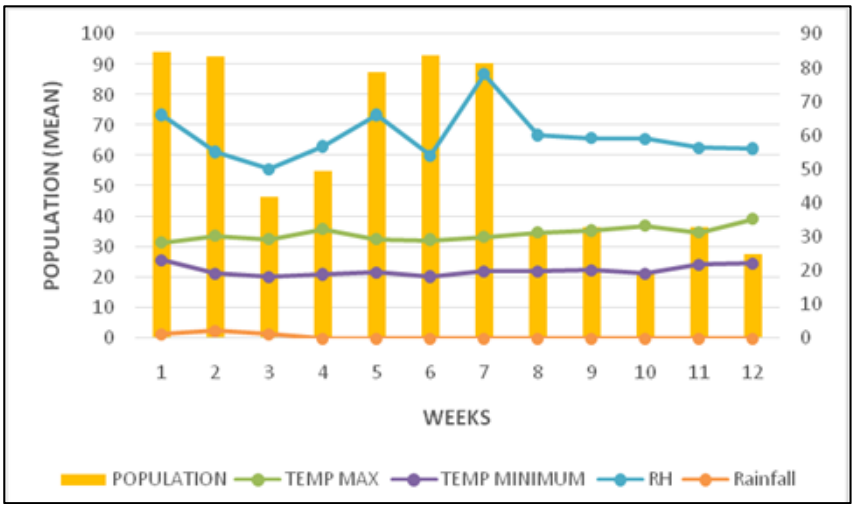

Fig 3: Effect of weather parameters on population magnitude of *B. cucurbitae* in watermelon-ecosystem in Kanchipuram district

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